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Hawaii-Southern California Training and Testing Activities Final Environmental Impact Statement/ Overseas Environmental Impact Statement

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3.7 Marine Mammals

Final
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PREFERRED ALTERNATIVE SYNOPSIS

The United States Department of the Navy considered all potential stressors that marine mammals could be exposed to from the Proposed Action. The following conclusions have been reached for the Preferred Alternative (Alternative 1):

- Acoustics: Navy training and testing activities have the potential to expose marine mammals to multiple acoustic stressors. Exposures to sound-producing activities presents risks to marine mammals that could include temporary or permanent hearing threshold shift, auditory masking, physiological stress, or behavioral responses. Because individual animals would typically only experience a small number of behavioral responses or temporary hearing threshold shifts per year due to exposure to acoustic stressors and these are very unlikely to lead to any costs or long-term consequences for individuals or populations.
- Explosives: Explosions in the water or near the water's surface present a risk to marine mammals located in close proximity to the explosion, because the resulting shock waves can cause injury or result in the death of an animal. If a marine mammal is farther from an explosion, the impulsive, broadband sounds introduced into the marine environment may cause temporary or permanent hearing threshold shift, auditory masking, physiological stress, or behavioral responses. Because most estimated impacts from explosions are behavioral responses or temporary threshold shifts and because the numbers of marine mammals potentially impacted by explosives are small as compared to each species respective abundance, population level effects are unlikely.
- Energy: Navy training and testing activities have the potential to expose marine mammals to multiple energy stressors. The likelihood and magnitude of energy impacts depends on the proximity of marine mammals to energy stressors. Based on the relatively weak strength of the electromagnetic field created by some Navy activities, a marine mammal would have to be in close proximity for there to be any effect and impacts on marine mammal migrating behaviors and navigational patterns are not anticipated. Potential impacts from high-energy lasers would only result for marine mammals directly struck by the laser beam. Statistical probability analyses demonstrate with a high level of certainty that no marine mammals would be struck by a high-energy laser. Energy stressors associated with Navy training and testing activities are temporary and localized in nature and, based on patchy distribution of animals, no impacts to individual marine mammals and marine mammal populations are anticipated.

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- Physical Disturbance and Strike: Marine mammals would be potentially exposed to multiple physical disturbance and strike stressors associated with Navy training and testing activities. The potential for impacts relies heavily on the probability that marine mammals would be in close proximity to a physical disturbance and strike stressor (e.g., a vessel or a non-explosive munition). Historical data on Navy ship strike records demonstrate a low occurrence of interactions with marine mammals over the last ten years. Since the Navy does not anticipate a change in the level of vessel use compared to the last decade, the potential for striking a marine mammal remains low. Physical disturbance due to vessel movement and in water devices of individual marine mammals may also occur, but any stress response of avoidance behavior would not be severe enough to have long-term fitness consequences for individual marine mammals. The use of in-water devices during Navy activities involves multiple types of vehicles or towed devices traveling on the water surface, through the water column, or along the seafloor, all of which have the potential to physically disturb or strike marine mammals. No recorded or reported instances of marine mammal strikes have resulted from in-water devices; therefore, impacts on individuals or long-term consequences to marine mammal populations are not anticipated. Potential physical disturbance and strike impacts from military expended materials and seafloor devices are determined through statistical probability analyses. Results for each of these physical disturbance and strike stressors suggests a very low potential for marine mammals to be struck by any of these items. Long-term consequences to marine mammal populations from physical disturbance and strike stressors associated with Navy training and testing activities are not anticipated.
- Entanglement: Marine mammals could be exposed to multiple entanglement sources associated with Navy training and testing activities. The potential for impacts is dependent on the probability that a marine mammal would encounter a potential entanglement stressor as well as the physical properties of the expended materials and the likelihood that a marine mammal could become entangled in the item. Physical characteristics of wires and cables, decelerators/parachutes, and biodegradable polymers, combined with the sparse distribution of these items throughout the Study Area, indicate a very low potential for marine mammals to encounter and become entangled in them. Long-term impacts to individual marine mammals and marine mammal populations from entanglement stressors associated with Navy training and testing activities are not anticipated.

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- Ingestion: Navy training and testing activities have the potential to expose marine mammals to multiple ingestion stressors and associated impacts. The likelihood and magnitude of impacts depend on the physical properties of the military expended items, the feeding behaviors of marine mammals that occur in the Study Area, and the likelihood that a marine mammal would encounter and incidentally ingest the items. Adverse impacts from ingestion of military expended materials would be limited to the unlikely event that a marine mammal would be harmed by ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. The likelihood that a marine mammal would encounter and subsequently ingest a military expended item associated with Navy training and testing activities is considered low. Long-term consequences to marine mammal populations from ingestion stressors associated with Navy training and testing activities are not anticipated.
- Secondary: Marine mammals could be exposed to multiple secondary stressors (indirect stressors to habitat or prey) associated with Navy training and testing activities in the Study Area. In-water explosions have the potential to injure or kill prey species that marine mammals feed on within a small area affected by the blast; however, impacts would not substantially impact prey availability for marine mammals. Explosion byproducts and unexploded munitions would have no meaningful effect on water or sediment quality; therefore, they are not considered to be secondary stressors for marine mammals. Metals are introduced into the water and sediments from multiple types of military expended materials. Evidence from a number of studies indicate metal contamination is localized and ephemeral and that bioaccumulation resulting from munitions was not observed in the studies specifically designed to look for bioaccumulation. Therefore, it is unlikely that impacts on marine mammal prey availability would occur. Several Navy training and testing activities (e.g., Bombing Exercise Air-to-Surface) introduce explosive byproducts into the marine environment that are potentially harmful in concentration; however, rapid dilution would occur and toxic concentrations are unlikely to be encountered. Furthermore, there is no evidence of acute toxicity or chronic accumulation in tissues of chemicals introduced by Navy activities that would significantly alter water quality to an extent that would result in overall habitat degradation for marine mammals. Transmission of marine mammal diseases and parasites are not considered likely from the Navy's trained marine mammals because strict protocols are in place to prevent such impacts on wild populations. Secondary stressors from Navy training and testing activities in the Study Area are not expected to have short-term impacts on individual marine mammals or long-term impacts on marine mammal populations. Secondary stressors may affect main Hawaiian Islands insular false killer whale and Hawaiian monk seal critical habitats.

3.7.1 Introduction

In this Environmental Impact Statement (EIS)/Overseas EIS (OEIS), potential impacts on marine mammals are evaluated based on their distribution and ecology relative to the stressor or activity being considered. Activities are evaluated for their potential impact on marine mammals in general, on stocks and populations as appropriate, and on species listed under the Endangered Species Act (ESA), in the Hawaii-Southern California Training and Testing (HSTT) Study Area (Study Area).

The following subsections provide introductions to marine mammal species that occur in the Study Area, including federally listed threatened or endangered species. General information relevant to all marine mammal species is provided in Section 3.7.2.1 (General Background), followed by subsections that discuss the status, habitats, population trends, predator-prey interactions, and species-specific threats. The complete analysis and summary of potential impacts of the proposed training and testing activities on marine mammals is found in Section 3.7.3 (Environmental Consequences) and Section 3.7.4 (Summary of Potential Impacts on Marine Mammals).

Throughout this section, references are made to three regions of the Pacific Ocean. These regions, delineated by the National Oceanic and Atmospheric Administration/National Marine Fisheries Service (NMFS) Science Centers, are defined for management purposes as (1) the Eastern North Pacific, an area in the Pacific Ocean that is east of 140 degrees (°) west (W) longitude and north of the equator; (2) the Central North Pacific, north of the equator and between the International Date Line (180° W longitude) and 140° W longitude; and (3) the Eastern Tropical Pacific, an area roughly extending from the United States (U.S.)-Mexico Border west to Hawaii and south to Peru.

Provisional 2015 Prohibited or Restricted Areas within HSTT

A 2015 HSTT-related settlement agreement temporarily prohibited or restricted Navy activities within specific areas in the HSTT Study Area. Under the terms of the settlement agreement executed in September 2015, the Navy agreed to temporarily prohibit or restrict the use of certain surface ship hull mounted active sonar and in-water explosives within defined areas until the expiration of the current HSTT Marine Mammal Protection Act (MMPA) Final Rule on 24 December 2018 or the earlier issuance of superseding environmental compliance documents. The settlement agreement measures have applied to the Navy's ongoing activities during Phase II since September 2015 and form part of the baseline environmental conditions that exist within the HSTT Study Area in the impact analysis. See Appendix K (Geographic Mitigation Assessment) for specific details on the settlement agreement prohibitions and restrictions and figures depicting these areas.

Additionally, and since 2009, the Navy has been implementing seasonal (from December 15 to April 15) geographic mitigation for certain activities within the Hawaii Range Complex in areas identified as having the highest humpback whale density. These seasonal mitigation areas were developed in coordination with National Marine Fisheries Service (NMFS) through previous consultations as a means to further reduce the potential for impacts on the humpback whale during calving season and were designated as the Humpback Whale Cautionary Area and Humpback Whale Special Reporting Areas. The Navy is proposing to continue to implement the current mitigation as detailed in Appendix K (Geographic Mitigation Assessment), with the exception of changes as noted in that appendix. These changes include expanding the size and extending the season (November 15–April 15) of the Humpback Whale Cautionary Area and renaming the mitigation area. The Navy will also continue to implement the Humpback Whale Special Reporting Areas as discussed in Appendix K.

While the Navy is not proposing to carry forward all of the temporary settlement agreement measures from September 2015 and other negotiated agreements, the Navy has completed an analysis of potential geographic mitigation and is proposing to implement specific mitigation within geographic areas in Hawaii and the Southern California portion of the HSTT Study Area. See Appendix K (Geographic Mitigation Assessment) for the complete mitigation area assessment and the proposed mitigation area measures to be implemented under the Proposed Action.

3.7.2 Affected Environment

3.7.2.1 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, 2016). In this document, Navy follows the naming conventions presented by NMFS in the applicable annual Stock Assessment Reports for the Pacific and Alaska covering the marine mammals present in the HSTT Study Area (Carretta et al., 2017c; Muto et al., 2017a).

All marine mammals in the United States are protected under the MMPA, and some species receive additional protection under the 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” (National Marine Fisheries Service, 2016h). 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 species in a management unit, such as with *Mesoplodon* beaked whales[1] and the two *Kogia* species occurring in the Southern California portion of the Study Area (Carretta et al., 2017c).

The ESA provides for listing species, subspecies, or distinct population segments 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 distinct population segment as, “any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature” (61 Federal Register 4722, 7 February 1996). If a population meets the criteria to be identified as a distinct population segment, it is eligible for listing under the ESA as a separate species (National Marine Fisheries Service, 2016h). MMPA stocks do not necessarily coincide with distinct population segments under the ESA (81 Federal Register 62660, September 8, 2016). In the HSTT Study Area there are, for example, three humpback whale distinct population segments (Bettridge et al., 2015) contained within two NMFS-designated stocks as described

[1] In Southern California, the *Mesoplodon* species *M. carlhubbsi*, *M. ginkgodens*, *M. perrini*, *M. peruvianus*, *M. stejnegeri* and *M. densirostris* have been grouped by NMFS into a single management unit (*Mesoplodon* spp.) in the Pacific Stock Assessment Reports.

in the Stock Assessment Report for Alaska (Carretta et al., 2016c; Muto et al., 2017b) and for the U.S. Pacific (Carretta et al., 2017c; Carretta et al., 2018a).

There are 39 marine mammal species known to exist in the Study Area, including 7 mysticetes (baleen whales), 25 odontocetes (dolphins and toothed whales), 6 pinnipeds (seals and sea lions), and the southern sea otter. Among these species there are multiple stocks managed by NMFS or the U.S. Fish and Wildlife Service (USFWS) in the United States Exclusive Economic Zone. These species and stocks are presented in Table 3.7-1 along with an abundance estimate, an associated coefficient of variation value, and minimum abundance as provided by the Stock Assessment Reports (Carretta et al., 2018a; Muto et al., 2017b). The abundance provided is an estimated number of animals in a stock that are present in the specific portion of U.S. waters covered by a particular Stock Assessment Report (National Marine Fisheries Service, 2016h). The coefficient of variation is a statistical term that describes the variation possible in an estimate; in this case, stock abundances. The minimum population estimate is either a direct count (e.g., pinnipeds on land) or the lower 20th percentile of a statistical abundance estimate for a stock.

For each species and stock, relevant information on their status, distribution, population trends, and ecology is presented in Section 3.7.2 (Affected Environment), incorporating the best available science in addition to the analyses provided in the most recent U.S. Pacific and Alaska Marine Mammal Stock Assessments (Carretta et al., 2017c; Carretta et al., 2018a; Muto et al., 2017a; Muto et al., 2017b), which cover those stocks present in the HSTT Study Area. As noted above, in some cases species are grouped into a single stock due to limited species-specific information, while in other cases a single species includes multiple stocks recognized for management purposes (e.g., spinner dolphins in Hawaii).

For summaries of the general biology and ecology of marine mammals beyond the scope of this EIS, see Berta et al. (2006); Hoelzel (2002); Jefferson et al. (2015); Reynolds and Rommel (1999); Rice (1998); Twiss and Reeves (1999). Additional species profiles and information on the biology, life history, species distribution and conservation of marine mammals can also be found through the following organizations:

- NMFS Office of Protected Resources (includes species distribution maps)
- Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (known as OBIS-SEAMAP) species profiles
- National Oceanic and Atmospheric Administration Cetacean Density and Distribution Mapping Working Group
- International Whaling Commission
- International Union for Conservation of Nature, Cetacean Specialist Group
- The Marine Mammal Commission
- Society for Marine Mammalogy

Four main types of marine mammals are generally recognized: cetaceans (whales, dolphins, and porpoises), pinnipeds (seals, sea lions, and walruses [walruses do not occur in the Study Area]), sirenians (manatees and dugongs [none of which occur in the Study Area]), and several species of marine carnivores (marine otters and polar bears [polar bears do not occur in the Study Area]) (Jefferson et al., 2015; Rice, 1998). To maintain consistency with past Navy analysis and retain familiar terminology, we have used Odontocetes for toothed whales, dolphins, and porpoises, Mysticetes for baleen whales, and Cetaceans to be inclusive of both. Odontocetes range in size from slightly longer than 3.3 feet (ft.) to more than 60 ft. and have teeth, which they use to capture and consume individual prey. Odontocetes are divided into several families. Mysticetes are universally large whales (more than 15 ft. as adults) that use baleen, a fibrous structure made of keratin (a type of protein like that found in human fingernails) instead of teeth, to feed. Mysticetes typically engulf, suck, or skim the water into their mouth and then push the water out as large quantities of prey, including small schooling fish, shrimp, and zooplankton (e.g., copepods and krill) are filtered by the baleen (Heithaus & Dill, 2009). Detailed reviews of the different groups of cetaceans can be found in Jefferson et al. (2015) and Perrin et al. (2009a). The different feeding strategies of mysticetes and odontocetes affect their distribution and occurrence patterns (Goldbogen et al., 2015).

Pinnipeds in the Study Area are also divided into two groups: phocids (true seals) and otariids (fur seals and sea lions). Phocids lack ear flaps, their fore flippers are short and have hair, and their hind flippers are oriented towards the back of their bodies and cannot be rotated forward. Otariids have external ear flaps, long hairless or partially haired fore flippers, and hind flippers that can be rotated beneath their bodies. Pinnipeds spend a large portion of their time in the Study Area on land at haulout sites used for resting and moulting, and at rookeries used for breeding and nursing young. All pinnipeds return to the water to forage. The only pinniped species that regularly occurs in Hawaii is the Hawaiian monk seal. Four species of pinnipeds (California sea lion, Guadalupe fur seal, northern elephant seal, and Pacific harbor seal) regularly occur in the Southern California Range Complex portion of the Study Area.

The southern sea otter (*Enhydra lutris nereis*) at San Nicolas Island is the only species of sea otter present in the Southern California portion of the HSTT Study Area. Sea otters rarely come ashore and spend most of their life nearshore where they regularly swim, feed, and rest.

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Table 3.7-1: Marine Mammals Occurrence within the HSTT Study Area

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] (CV)/Minimum Population	Occurrence in Study Area		
					Coastal (<200 m Depth)	Open Ocean (>200 m Depth)	Bays and Harbors[5]
Order Cetacea							
Suborder Mysticeti (baleen whales)							
Blue whale	*Balaenoptera musculus*	Eastern North Pacific	Endangered/Depleted	1,647 (0.07)/1,551	SOCAL	SOCAL	-
		Central North Pacific	Endangered/Depleted	133 (1.09)/63	HRC	HRC	-
Bryde's whale	*Balaenoptera brydei/edeni*	Eastern Tropical Pacific	-	unknown	SOCAL	SOCAL	-
		Hawaiian	-	1,751 (0.29)/1,378	HRC	HRC	-
Fin whale	*Balaenoptera physalus*	California, Oregon, and Washington	Endangered/Depleted	9,029 (0.12)/8,127	SOCAL	SOCAL	-
		Hawaiian	Endangered/Depleted	154 (1.05)/75	HRC	HRC	-
Gray whale	*Eschrichtius robustus*	Eastern North Pacific	-	26,960 (0.05)/25,849	SOCAL	SOCAL	-
		Western North Pacific	Endangered/Depleted	175 (0.05)/167	SOCAL	SOCAL	-
Humpback whale	*Megaptera novaeangliae*	California, Oregon, Washington	Endangered/Depleted	2,900 na/2,784	SOCAL	SOCAL	-
		Central North Pacific	-/Depleted	10,103 (0.30)/7,890	HRC	HRC	-

[1] Taxonomy follows Committee on Taxonomy (2016); (Committee on Taxonomy, 2017)

[2] Stock designations for the U.S. Exclusive Economic Zones are from the Pacific (Carretta et al., 2017c; Carretta et al., 2018a, 2018b) and Alaska (Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018) Stock Assessment Reports prepared by National Marine Fisheries Service

[3] Populations or stocks defined by the MMPA as "strategic" for one of the following reasons: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, numbers are declining and species are likely to be listed as threatened species under the ESA within the foreseeable future; (3) species are listed as threatened or endangered under the ESA; (4) species are designated as depleted under the MMPA.

[4] Stock Abundance, Coefficient of variation (CV), and minimum population (min) are numbers provided by the Stock Assessment Reports (Carretta et al., 2017c; Carretta et al., 2018a, 2018b; Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018). The stock abundance is an estimate of the number of animals within the stock. The CV is a statistical metric used as an indicator of the uncertainty in the abundance estimate. The minimum population estimate is either a direct count (e.g., pinnipeds on land) or the lower 20th percentile of a statistical abundance estimate.

[5] Occurrence in Bays and Harbors includes Pearl Harbor (Hawaii) and San Diego Bay (California) as depicted in Figure 1.1 for the HSTT.

Table 3.7-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] (CV)/Minimum Population	Occurrence in Study Area		
					Coastal (<200 m Depth)	Open Ocean (>200 m Depth)	Bays and Harbors[5]
Suborder Mysticeti (baleen whales) (continued)							
Minke whale	*Balaenoptera acutorostrata*	California, Oregon, and Washington	-	636 (0.72)/369	SOCAL	SOCAL	-
		Hawaiian	-	unknown	HRC	HRC	-
Sei whale	*Balaenoptera borealis*	Eastern North Pacific	Endangered/Depleted	519 (0.4)/374	SOCAL	SOCAL	-
		Hawaii	Endangered/Depleted	391 (0.90)/204	HRC	HRC	-
Suborder Odontoceti (toothed whales)							
Family Physeteridae (sperm whale)							
Sperm whale	*Physeter macrocephalus*	California, Oregon, and Washington	Endangered/Depleted	1.997 (0.57)/1,270	SOCAL	SOCAL	-
		Hawaiian	Endangered/Depleted	4,559 (0.33)/3,478	HRC	HRC	-
Family Kogiidae (sperm whales)							
Dwarf sperm whale	*Kogia sima*	California, Oregon, and Washington	-	unknown	SOCAL	SOCAL	-
		Hawaiian	-	unknown	HRC	HRC	-
Pygmy sperm whale	*Kogia breviceps*	California, Oregon, and Washington	-	4,111 (1.12)/1,924	SOCAL	SOCAL	-
		Hawaiian	-	unknown	HRC	HRC	-

[1] Taxonomy follows Committee on Taxonomy (2016, 2017)

[2] Stock designations for the U.S. Exclusive Economic Zones are from the Pacific (Carretta et al., 2017c; Carretta et al., 2018a, 2018b) and Alaska (Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018) Stock Assessment Reports prepared by National Marine Fisheries Service

[3] Populations or stocks defined by the MMPA as "strategic" for one of the following reasons: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, numbers are declining and species are likely to be listed as threatened species under the ESA within the foreseeable future; (3) species are listed as threatened or endangered under the ESA; (4) species are designated as depleted under the MMPA.

[4] Stock Abundance, Coefficient of variation (CV), and minimum population (min) are numbers provided by the Stock Assessment Reports (Carretta et al., 2017c; Carretta et al., 2018a, 2018b; Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018). The stock abundance is an estimate of the number of animals within the stock. The CV is a statistical metric used as an indicator of the uncertainty in the abundance estimate. The minimum population estimate is either a direct count (e.g., pinnipeds on land) or the lower 20th percentile of a statistical abundance estimate.

[5] Occurrence in Bays and Harbors includes Pearl Harbor (Hawaii) and San Diego Bay (California) as depicted in Figure 1.1 for the HSTT.

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Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] (CV)/Minimum Population	Occurrence in Study Area		
					Coastal (<200 m Depth)	Open Ocean (>200 m Depth)	Bays and Harbors[5]
Family Ziphiidae (beaked whales)							
Baird's beaked whale	*Berardius bairdii*	California, Oregon, and Washington	-	2,697 (0.60)/1,633	-	SOCAL	-
Blainville's beaked whale	*Mesoplodon densirostris*	Hawaiian	-	2,105 (1.13)/980	-	HRC	-
Cuvier's beaked whale	*Ziphius cavirostris*	California, Oregon, and Washington	-	3,274 (0.67)/2,059	-	SOCAL	-
		Hawaiian	-	723 0.69/428	-	HRC	-
Longman's beaked whale	*Indopacetus pacificus*	Hawaiian	-	7,619 (0.66)/4,592	-	HRC	-
Mesoplodont beaked whales[6]	*Mesoplodon spp.*	California, Oregon, and Washington	-	3,044 (0.54)/1,967	-	SOCAL	-

[1] Taxonomy follows Committee on Taxonomy (2016, 2017)

[2] Stock designations for the U.S. Exclusive Economic Zones are from the Pacific (Carretta et al.; Carretta et al., 2017d; Carretta et al., 2018a, 2018b) and Alaska (Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018) Stock Assessment Reports prepared by National Marine Fisheries Service

[3] Populations or stocks defined by the MMPA as "strategic" for one of the following reasons: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, numbers are declining and species are likely to be listed as threatened species under the ESA within the foreseeable future; (3) species are listed as threatened or endangered under the ESA; (4) species are designated as depleted under the MMPA.

[4] Stock Abundance, Coefficient of variation (CV), and minimum population (min) are numbers provided by the Stock Assessment Reports (Carretta et al., 2017c; Carretta et al., 2018a, 2018b; Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018). The stock abundance is an estimate of the number of animals within the stock. The CV is a statistical metric used as an indicator of the uncertainty in the abundance estimate. The minimum population estimate is either a direct count (e.g., pinnipeds on land) or the lower 20th percentile of a statistical abundance estimate.

[5] Occurrence in Bays and Harbors includes Pearl Harbor (Hawaii) and San Diego Bay (California) as depicted in Figure 1.1 for the HSTT.

[6] The six Mesoplodont beaked whale species in Southern California are (*M. densirostris, M. carlhubbsi, M. ginkgodens, M. perrini, M. peruvianus, M. stejnegeri*)

Table 3.7-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] (CV)/Minimum Population	Occurrence in Study Area		
					Coastal (<200 m Depth)	Open Ocean (>200 m Depth)	Bays and Harbors[5]
Family Delphinidae (dolphins)							
Bottlenose dolphin	*Tursiops truncatus*	California Coastal	-	453 (0.06)/346	SOCAL	SOCAL	San Diego Bay
		California, Oregon, and Washington Offshore	-	1,924 (0.54)/1,255	SOCAL	SOCAL	-
		Hawaiian Pelagic	-	21,815 (0.57)/13,957	HRC	HRC	-
		Kauai and Niihau	-	unknown	HRC	HRC	-
		Oahu	-	unknown	HRC	HRC	--
		4-Island Region	-	unknown	HRC	HRC	-
		Hawaii Island	-	unknown	HRC	HRC	-
False killer whale	*Pseudorca crassidens*	Main Hawaiian Islands Insular	Endangered/Depleted	167 (0.14)/149	HRC	HRC	-
		Hawaii Pelagic	-	1,540 (0.66)/928	HRC	HRC	-
		Northwestern Hawaiian Islands	-	617 (1.11) 290	HRC	HRC	-
Fraser's dolphin	*Lagenodelphis hosei*	Hawaiian	-	51,491 (0.66)/31,034	HRC	HRC	-

[1] Taxonomy follows Committee on Taxonomy (2016, 2017)

[2] Stock designations for the U.S. Exclusive Economic Zones are from the Pacific (Carretta et al., 2017c; Carretta et al., 2018a, 2018b) and Alaska (Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018) Stock Assessment Reports prepared by National Marine Fisheries Service

[3] Populations or stocks defined by the MMPA as "strategic" for one of the following reasons: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, numbers are declining and species are likely to be listed as threatened species under the ESA within the foreseeable future; (3) species are listed as threatened or endangered under the ESA; (4) species are designated as depleted under the MMPA.

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Table 3.7-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] (CV)/Minimum Population	Occurrence in Study Area		
					Coastal (<200 m Depth)	Open Ocean (>200 m Depth)	Bays and Harbors[5]
Family Delphinidae (dolphins) (continued)							
Killer whale	*Orcinus orca*	Eastern North Pacific Offshore	-	300 (0.1)/276	SOCAL	SOCAL	-
		Eastern North Pacific Transient/West Coast Transient[7]	-	243 unk/243	SOCAL	SOCAL	-
		Hawaiian	-	146 (0.96)/74	HRC	HRC	-
Long-beaked common dolphin	*Delphinus capensis*	California	-	101,305 (0.49)/68,432	SOCAL	SOCAL	-
Melon-headed whale	*Peponocephala electra*	Hawaiian Islands	-	8,666 (1.00)/4,299	HRC	HRC	-
		Kohala Resident		447 (0.12)/404	HRC	HRC	-
Northern right whale dolphin	*Lissodelphis borealis*	California, Oregon, & Washington	-	26,556 (0.44)/18,608	SOCAL	SOCAL	-
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	California, Oregon, & Washington	-	26,814 (0.28)/21,195	SOCAL	SOCAL	-

[1] Taxonomy follows Committee on Taxonomy (2016, 2017)

[2] Stock designations for the U.S. Exclusive Economic Zones are from the Pacific (Carretta et al., 2017c; Carretta et al., 2018a, 2018b) and Alaska (Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018) Stock Assessment Reports prepared by National Marine Fisheries Service

[3] Populations or stocks defined by the MMPA as "strategic" for one of the following reasons: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, numbers are declining and species are likely to be listed as threatened species under the ESA within the foreseeable future; (3) species are listed as threatened or endangered under the ESA; (4) species are designated as depleted under the MMPA.

[4] Stock Abundance, Coefficient of variation (CV), and minimum population (min) are numbers provided by the Stock Assessment Reports (Carretta et al., 2017c; Carretta et al., 2018a, 2018b; Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018). The stock abundance is an estimate of the number of animals within the stock. The CV is a statistical metric used as an indicator of the uncertainty in the abundance estimate. The minimum population estimate is either a direct count (e.g., pinnipeds on land) or the lower 20th percentile of a statistical abundance estimate.

[5] Occurrence in Bays and Harbors includes Pearl Harbor (Hawaii) and San Diego Bay (California) as depicted in Figure 1.1 for the HSTT.

[7] This stock is mentioned briefly in the Pacific Stock Assessment Report (Carretta et al., 2017c; Carretta et al., 2018a) and referred to as the "Eastern North Pacific Transient" stock, however, the Alaska Stock Assessment Report contains assessments of all transient killer whale stocks in the Pacific and the Alaska Stock Assessment Report refers to this same stock as the "West Coast Transient" stock (Muto et al., 2017a; Muto et al., 2017b).

Table 3.7-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] (CV)/Minimum Population	Occurrence in Study Area		
					Coastal (<200 m Depth)	Open Ocean (>200 m Depth)	Bays and Harbors[5]
Family Delphinidae (dolphins) (continued)							
Pantropical spotted dolphin	*Stenella attenuata*	Oahu	-	unknown	HRC	HRC	-
		4-Island	-	unknown	HRC	HRC	-
		Hawaii Island	-	unknown	HRC	HRC	-
		Hawaii Pelagic	-	55,795 (0.40)/40,338	HRC	HRC	-
Pygmy killer whale	*Feresa attenuata*	Tropical	-	na	SOCAL	SOCAL	-
		Hawaiian	-	10,640 (0.53)/6,998	HRC	HRC	-
Risso's dolphins	*Grampus griseus*	California, Oregon, & Washington	-	6,336 (0.32)/4,817	SOCAL	SOCAL	-
		Hawaiian	-	11,613 (0.43)/8,210	HRC	HRC	-
Rough-toothed dolphin	*Steno bredanensis*	na[8]	-	unknown	SOCAL	SOCAL	-
		Hawaiian	-	72,528 (0.39)/52,833	HRC	HRC	-
Short-beaked common dolphin	*Delphinus delphis*	California, Oregon, and Washington	-	969,861 (0.17)/839,325	SOCAL	SOCAL	-

[1] Taxonomy follows Committee on Taxonomy (2016, 2017)

[2] Stock designations for the U.S. Exclusive Economic Zones are from the Pacific (Carretta et al., 2017c; Carretta et al., 2018a, 2018b) and Alaska (Muto et al., 2017a; Muto et al., 2017b) Stock Assessment Reports prepared by National Marine Fisheries Service

[3] Populations or stocks defined by the MMPA as "strategic" for one of the following reasons: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, numbers are declining and species are likely to be listed as threatened species under the ESA within the foreseeable future; (3) species are listed as threatened or endangered under the ESA; (4) species are designated as depleted under the MMPA.

[4] Stock Abundance, Coefficient of variation (CV), and minimum population (min) are numbers provided by the Stock Assessment Reports (Carretta et al., 2017c; Carretta et al., 2018a, 2018b; Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018). The stock abundance is an estimate of the number of animals within the stock. The CV is a statistical metric used as an indicator of the uncertainty in the abundance estimate. The minimum population estimate is either a direct count (e.g., pinnipeds on land) or the lower 20th percentile of a statistical abundance estimate.

[5] Occurrence in Bays and Harbors includes Pearl Harbor (Hawaii) and San Diego Bay (California) as depicted in Figure 1.1 for the HSTT.

[8] Rough-toothed dolphin has a range known to include the waters off Southern California but there is no recognized stock for the U.S West Coast.

Table 3.7-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] (CV)/Minimum Population	Occurrence in Study Area		
					Coastal (<200 m Depth)	Open Ocean (>200 m Depth)	Bays and Harbors[5]
Family Delphinidae (dolphins) (continued)							
Short-finned pilot whale	*Globicephala macrorhynchus*	California, Oregon, & Washington	-	836 (0.79)/466	SOCAL	SOCAL	-
		Hawaiian	-	19,503 (0.49)/13,197	HRC	HRC	-
Spinner dolphin	*Stenella longirostris*	Hawaii Pelagic	-	unknown	HRC	HRC	-
		Hawaii Island	-	665 (0.09)/617	HRC	HRC	-
		Oahu and 4-Island		na	HRC	HRC	-
		Kauai and Niihau	-	na	HRC	HRC	-
		Kure and Midway	-	unknown	HRC	HRC	-
		Pearl and Hermes	-	unknown	HRC	HRC	-
Striped dolphin	*Stenella coeruleoalba*	California, Oregon, and Washington	-	29,211 (0.20)/24,782	SOCAL	SOCAL	-
		Hawaiian	-	61,021 (0.38)/44,922	HRC	HRC	-

[1] Taxonomy follows Committee on Taxonomy (2016, 2017)

[2] Stock designations for the U.S. Exclusive Economic Zones are from the Pacific (Carretta et al., 2017c; Carretta et al., 2018a, 2018b) and Alaska (Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018) Stock Assessment Reports prepared by National Marine Fisheries Service

[3] Populations or stocks defined by the MMPA as "strategic" for one of the following reasons: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, numbers are declining and species are likely to be listed as threatened species under the ESA within the foreseeable future; (3) species are listed as threatened or endangered under the ESA; (4) species are designated as depleted under the MMPA.

[4] Stock Abundance, Coefficient of variation (CV), and minimum population (min) are numbers provided by the Stock Assessment Reports (Carretta et al., 2017c; Carretta et al., 2018a, 2018b; Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018). The stock abundance is an estimate of the number of animals within the stock. The CV is a statistical metric used as an indicator of the uncertainty in the abundance estimate. The minimum population estimate is either a direct count (e.g., pinnipeds on land) or the lower 20th percentile of a statistical abundance estimate.

[5] Occurrence in Bays and Harbors includes Pearl Harbor (Hawaii) and San Diego Bay (California) as depicted in Figure 1.1 for the HSTT.

Table 3.7-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	Scientific Name[1]	Stock[2]	ESA/MMPA Status[3]	Stock Abundance[4] (CV)/Minimum Population	Occurrence in Study Area		
					Coastal (<200 m Depth)	Open Ocean (>200 m Depth)	Bays and Harbors[5]
Family Phocoenidae (porpoises)							
Dall's porpoise	*Phocoenoides dalli*	California, Oregon, and Washington	-	25,750 (0.45)/17,954	SOCAL	SOCAL	-
Order Carnivora							
Suborder Caniformiader							
Family Mustelidae							
Southern sea otter	*Enhydra lutris nereis*	California Stock	Threatened/Depleted	2,826 na/2,723	SOCAL	-	-
Suborder Pinnipedia							
Family Phocidae (true seals)							
Harbor seal	*Phoca vitulina*	California	-	30,968 na/27,348	SOCAL	SOCAL	San Diego Bay
Hawaiian monk seal	*Neomonachus schauinslandi*	Hawaiian	Endangered/Depleted	1,415 na/1,384	HRC	HRC	Pearl Harbor
Northern elephant seal	*Mirounga angustirostris*	California	-	179,000 na/81,368	SOCAL	SOCAL	-
Family Otariidae (eared seal)							
California sea lion	*Zalophus californianus*	U.S. Stock	-	257,606 na/233,515	SOCAL	SOCAL	San Diego Bay
Northern fur seal	*Callorhinus ursinus*	California	-	14,050 na/7,524	SOCAL	SOCAL	-
Guadalupe fur seal	*Arctocephalus townsendi*	Mexico to California	Threatened/Depleted	20,000 na/15,830	SOCAL	SOCAL	

Notes: na = not available, SOCAL = Southern California portion of the HSTT Study Area, HRC = Hawaii Range Complex, CV = coefficient of variation, ESA = Endangered Species Act, MMPA = Marine Mammal Protection Act.

[1] Taxonomy follows Committee on Taxonomy (2016, 2017)

[2] Stock designations for the U.S. Exclusive Economic Zones are from the Pacific (Carretta et al., 2017c; Carretta et al., 2018a, 2018b) and Alaska (Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018) Stock Assessment Reports prepared by National Marine Fisheries Service

[3] Populations or stocks defined by the MMPA as "strategic" for one of the following reasons: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, numbers are declining and species are likely to be listed as threatened species under the ESA within the foreseeable future; (3) species are listed as threatened or endangered under the ESA; (4) species are designated as depleted under the MMPA.

[4] Stock Abundance, Coefficient of variation (CV), and minimum population (min) are numbers provided by the Stock Assessment Reports (Carretta et al., 2017c; Carretta et al., 2018a, 2018b; Muto et al., 2017a; Muto et al., 2017b; Muto et al., 2018). The stock abundance is an estimate of the number of animals within the stock. The CV is a statistical metric used as an indicator of the uncertainty in the abundance estimate. The minimum population estimate is either a direct count (e.g., pinnipeds on land) or the lower 20th percentile of a statistical abundance estimate.

[5] Occurrence in Bays and Harbors includes Pearl Harbor (Hawaii) and San Diego Bay (California) as depicted in Figure 1.1 for the HSTT.

Species Unlikely to be Present in Study Area

Several species that may be present in the northern Pacific Ocean east of the International Date Line have an extremely low probability of presence in the Study Area. This includes species that have a remote likelihood of occurring regularly in the Study Area, but may enter the Study Area during anomalous ocean-temperature shifts. These species are considered extralimital, meaning there may be a small number of sighting or stranding records within the Study Area, but that the Study Area is outside species current and expected range of normal occurrence. Those species carried forward for analysis are those likely to be found in the Study Area based on the most recent data available, and do not include species that may have once inhabited or transited the area but have not been sighted in recent years (e.g., species which were extirpated from factors such as 19th and 20th century commercial exploitation). Species unlikely to be present in the Study Area include the North Pacific right whale (*Eubalaena japonica*), harbor porpoise (*Phocoena phocoena*), Deraniyagala's beaked whale (*Mesoplodon hotaula*), and Steller sea lion (*Eumetopias jubatus*), and have been excluded from subsequent analysis for the reasons described below.

North Pacific Right Whale (*Eubalaena japonica*)

The likelihood of a North Pacific right whale being present in the Study Area is extremely low as in recent years this species has only been routinely observed or acoustically detected in the Bering Sea (Brownell et al., 2001; National Marine Fisheries Service, 2017a; Shelden et al., 2005; Wade et al., 2010; Wade et al., 2011; Wright et al., 2018; Wright et al., In press; Zerbini et al., 2010; Zerbini et al., 2015), with occasional sightings of individuals in the Gulf of Alaska (Matsuoka et al., 2014; Širović et al., 2015a; Wade et al., 2011), waters off British Columbia and the border with Washington state (Širović et al., 2015a; U.S. Department of the Navy, 2015c), and Southern California (Muto et al., 2018; WorldNow, 2017). The most recent estimated population for the eastern North Pacific right whale is between 28 and 31 individuals (Muto et al., 2018). Although this estimate may be reflective of a Bering Sea subpopulation, the total eastern North Pacific population is unlikely to be much larger (Wade et al., 2010). A right whale was last observed in the Maui Basin (Hawaiian waters) in April 1996 (Salden & Mickelsen, 1999). Rare sightings of individual animals are typical of documented sightings, such as those of a single right whale on three occasions between 25 March and 11 April 1979 in Hawaiian waters (Herman et al., 1980; Rowntree et al., 1980). These individual North Pacific right whales sighted near the Hawaiian Islands are considered "vagrants" as this region is not within the typical current geographic range of this species (Reilly et al., 2008). There have been only four sightings, each of a single right whale, in Southern California waters over approximately the last 30 years (in 1988, 1990, 1992, and 2017) (Brownell et al., 2001; Carretta et al., 1994; National Marine Fisheries Service, 2017a; WorldNow, 2017). Sightings off California are rare, and there is no evidence that the western coast of the United States was ever highly frequented by this species (Brownell et al., 2001; National Marine Fisheries Service, 2017a; Scammon, 1874). Historically, even during the period of U.S. West Coast whaling through the 1800s, right whales were considered uncommon to rare off California (Reeves & Smith, 2010; Scammon, 1874). For the reasons presented above, North Pacific right whales are not expected to be present during any proposed training or testing activities and as a result are considered extralimital for purposes of the analysis.

Deraniyagala's beaked whale (*Mesoplodon hotaula*)

As a relatively newly resurrected species (Dalebout et al., 2014), Deraniyagala's beaked whale is known from seven specimens discovered since the 1960s across the equatorial Pacific Ocean and equatorial Indian Ocean. In 1965, biologists had reclassified *Mesoplodon hotaula* as being the same as ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*), but recent review of genetic and morphological information supports the recognition of this previously synonymized species (Dalebout et al., 2014). The nearest known location for *M. hotaula* is Palmyra Island and Kingman Reef (in the Northern Line Islands), which are approximately 1,000 nautical miles (NM) south of Hawaii (Baumann-Pickering et al., 2016). Passive acoustic monitoring at seamounts a few hundred miles to the south of Oahu determined that the expectation of encountering sounds from Deraniyagala's beaked whales was not supported (Baumann-Pickering et al., 2016; Klinck et al., 2015; McDonald et al., 2009). The species has not been included in the Pacific Stock Assessment Report (Carretta et al., 2015; Carretta et al., 2017c; Carretta et al., 2017d; Carretta et al., 2018b).

Harbor Porpoise (*Phocoena phocoena*)

Harbor porpoises are not present in Hawaii. The likelihood of a harbor porpoise being present in the Southern California portion of the HSTT Study Area is extremely low as this species rarely occurs south of Point Conception (Barlow, 1988; Carretta et al., 2015; Carretta et al., 2017c; Dohl et al., 1983; Forney et al., 2014), which is approximately 100 NM north of the Southern California portion of the HSTT Study Area. Harbor porpoises were not detected during any of the 18 aerial surveys conducted in the Southern California range complex from 2008 through 2013 (Jefferson et al., 2014; Smultea et al., 2014). In the eastern north Pacific, harbor porpoises occur in nearshore coastal waters (generally within a mile or two of shore) from Point Conception to Alaska (Carretta et al., 2015; Forney et al., 2014; Gaskin, 1992). Based on genetic differences and discontinuities identified from aerial surveys, four separate stocks are recognized off California: (1) a northern California/southern Oregon stock, (2) a San Francisco-Russian River stock, (3) a Monterey Bay stock, and (4) a Morro Bay stock (Carretta et al., 2015; Carretta et al., 2017c). The southern boundary for the Morro Bay stock is Point Conception (Carretta et al., 2015; Carretta et al., 2017c), which is far to the north of the HSTT Study Area.

Steller Sea Lion (*Eumetopias jubatus*)

Steller sea lions range along the north Pacific from northern Japan to California (Perrin et al., 2009b), with centers of abundance and distribution in the Gulf of Alaska and Aleutian Islands. Steller sea lions are rarely sighted in Southern California waters—there have not been any documented interactions with any California fisheries in over two decades, and they are not expected to be present in the Study Area. In 2011, a vagrant Steller sea lion was observed hauled out at the Point Loma Space and Naval Warfare Systems Command facility in San Diego Bay and a vagrant individual was observed in the water at the entrance channel during the monitoring of a pile driving project in 2015 (U.S. Department of the Navy, 2015b). Aerial surveys for pinnipeds in the Channel Islands from 2011 to 2015 encountered a single Steller sea lion at San Nicolas Island in 2013 (Lowry et al., 2017). It is most likely that these extralimital Steller sea lions in the HSTT Study Area would be from the Eastern Distinct Population Segment, which is not listed as threatened or endangered under the ESA.

3.7.2.1.1 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, based on the species, can range from several to several thousand individuals. For example, 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 acoustic effects modeling to represent a more realistic patchy distribution for the given density. 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 (U.S. Department of the Navy, 2017c) and that report include tables of group size information by species along with relevant citations.

3.7.2.1.2 Habitat Use

Marine mammals occur in every marine environment in the Study Area, from bays, harbors, and coastal waters to open ocean environments in the middle of the Pacific Ocean. 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 in upwelling zones (Di Lorenzo et al., 2010; Jefferson et al., 2015), such as the upwelling zone in the Southern California Bight (Santora et al., 2017). While most baleen whales are migratory, some species such as fin whales have been documented with an undetermined component of their population present within Southern California year-round. 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 HSTT Study Area, especially in Southern California. In Hawaii, many of the small odontocetes range throughout the waters associated with the island chain, while some have a stable population and are considered “resident” to an area (Baird et al., 2015a). In the Pacific, pinnipeds occur in coastal habitats, in waters over the continental shelves, and may migrate through the mid-ocean as far north as Alaska and the middle of the north Pacific near the International Date Line. Sea otters are the most coastal group of marine mammals and require land or shallow coastal waters as habitat for reproducing, resting, and feeding.

In 2011, the National Oceanic and Atmospheric Administration convened a working group to map cetacean density and distribution within U.S. waters. 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., 2015; Van Parijs, 2015).

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. (2015) 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, including the potential addition of newly defined areas. Additionally, biologically important areas identified in the

HSTT study area (Baird et al., 2015a; Calambokidis et al., 2015) do not represent the totality of important habitat throughout the marine mammals' full range. The stated intention is to serve as a resource management tool and are specifically not intended to serve as exclusionary areas. The currently identified boundaries should be considered dynamic and subject to change based on new information, such 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 Hawaii and U.S. West Coast biologically important areas, were compiled and published in March 2015 (Aquatic Mammals, 2015a, 2015b; Baird et al., 2015a; Calambokidis et al., 2015; Ferguson et al., 2015).

In the Hawaii portion of the HSTT Study Area, 21 biologically important areas for 12 cetacean species have been identified (Baird et al., 2015a). These include 20 small and resident population areas for species including dwarf sperm whales, Blainville's beaked whales, Cuvier's beaked whales, pygmy killer whales, short-finned pilot whales, melon-headed whales, false killer whales, pantropical spotted dolphins, spinner dolphins, rough-toothed dolphins, and common bottlenose dolphins (see Appendix K for figures depicting these areas). In addition, six non-contiguous areas located adjacent to the eight main Hawaiian Islands have been designated as a humpback whale reproductive area (Baird et al., 2015a).

Twenty eight biologically important areas were identified for four species off the U.S. West Coast (Calambokidis et al., 2015), with five of those areas located within or overlapping the Southern California portion of the Study Area (see Appendix K for figures depicting these areas). These identified areas include four feeding areas for blue whales and a migration area for gray whales (Calambokidis et al., 2015). These areas are not intended to reflect a complete list of areas where species engage in important behavioral activities, are not equivalent to habitat or range, and likely represent only a fraction of a species' overall range (Ferguson et al., 2015).

Outside the processes established by the Cetacean Density and Distribution Mapping Working Group, additional areas to consider for mitigation were also suggested by members of the public during the scoping process and as part of negotiated legal temporary settlements and agreements. These other areas for consideration are described and analyzed in detail along with the identified biologically important areas in Appendix K (Geographic Mitigation Assessment). These other areas are locations that the Navy considered as part of the analysis of potential mitigation measures. The findings in Appendix K are summarized and integrated into Chapter 5 (Mitigation).

3.7.2.1.3 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 estimates of time at depth based on available research. The dive data and group size information compiled in this technical report were developed for the Navy acoustic effects modeling.

3.7.2.1.4 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 sensory cells (called hair cells) in the cochlea, which transforms acoustic energy into electrical neural impulses that are transferred by the auditory nerve to 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, 2014a; 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 (Houser & Mulsow, 2016; Ketten, 1998).

The most accurate means of determining the hearing capabilities of marine mammal species are direct measures that assess the sensitivity of the auditory system (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 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 increasingly 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., 2007; Nachtigall et al., 2008; Supin et al., 2001).

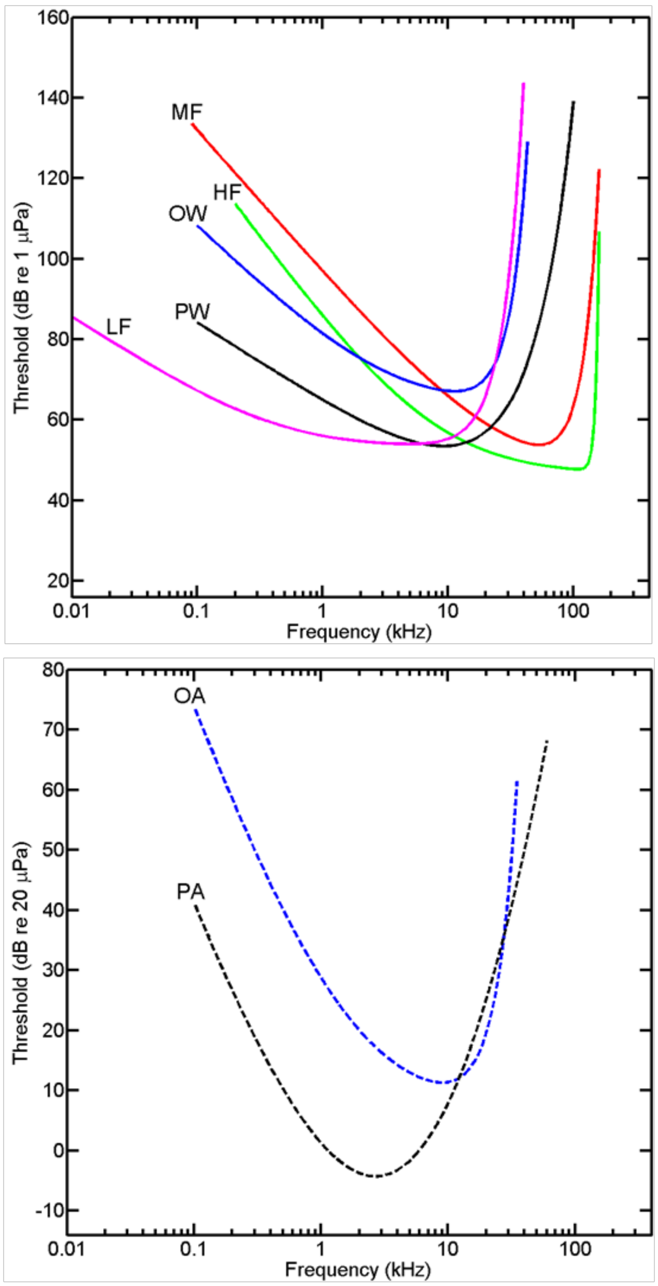
These auditory evoked potential methods, which measure electrical potentials generated by the auditory system in response to sound and do not require the extensive training of psychophysical methods, can provide an efficient estimate of behaviorally measured sensitivity (Finneran & Houser, 2006; Schlundt 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 3.7-2 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 (group HF: porpoises, Kogia spp.), mid-frequency cetaceans (group MF: delphinids, beaked whales, sperm whales), low-frequency cetaceans (group LF: mysticetes), otariids and other non-phocid marine carnivores in water and air (groups OW and OA: sea lions, walruses, otters, polar bears), and phocids in water and air (group PW and PA: true seals). Note that the designations of high-, mid-, and low-frequency cetaceans are based on relative differences in sensitivity between groups, as opposed to conventions used to describe active sonar systems. For Phase III analyses a single representative composite audiogram (Figure 3.7-1) 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* (U.S. Department of the Navy, 2017a).

Table 3.7-2: 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
	Pygmy sperm whale
Mid-frequency cetaceans	Baird's beaked whale
	Blainville's beaked whale
	Common bottlenose dolphin
	Cuvier's beaked whale
	False killer whale
	Fraser's dolphin
	Ginkgo-toothed beaked whale
	Hubbs' beaked whale
	Killer whale
	Long-beaked common dolphin
	Longman's beaked whale
	Melon-headed whale
	Northern right whale dolphin
	Pacific white-sided dolphin
	Pantropical spotted dolphin
	Perrin's beaked whale
	Pygmy beaked whale
	Pygmy killer whale
	Risso's dolphin
	Rough-toothed dolphin
	Short-beaked common dolphin
	Short-finned pilot whale
	Sperm whale
	Spinner dolphin
	Striped dolphin
	Stejneger's beaked whale
Low-frequency cetaceans	Blue whale
	Bryde's whale
	Fin whale
	Gray whale
	Humpback whale
	Minke whale

Hearing Group	***Species within the Study Area***
	Sei whale
Otariids and other non-phocid marine carnivores	California sea lion
	Guadalupe fur seal
	Northern fur seal
	Southern sea otter
Phocids	Harbor seal
	Hawaiian monk seal
	Northern elephant seal



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

Figure 3.7-1: Composite Audiograms for Hearing Groups Likely Found in the Study Area

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.

The mid-frequency cetacean composite audiogram is consistent with recently published behavioral audiograms of killer whales (Branstetter et al., 2017). The otariid and phocid composite audiograms are consistent with recently published behavioral audiograms of pinnipeds; these behavioral audiograms also show that 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).

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 to several kilohertz, and have source levels of 150 to 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, sirenians, 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, the calls of manatees and dugongs, 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 (500–200 µs), specialized biosonar clicks 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. 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).

3.7.2.1.5 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, 2011c, 2011h) provide a general discussion of marine mammal conservation and the threats they face. As detailed in National Marine Fisheries Service (2011f), 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 (Bradford & Lyman, 2015; Carretta et al., 2016b; Helker et al., 2015). The causes for strandings include infectious disease, parasite infestation, climate change reducing 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, tectonic events such as underwater earthquakes, and ingestion or interaction with marine debris (for more information see NMFS Marine Mammal Stranding Response Fact Sheet; (National Marine Fisheries Service, 2016k)). 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, 2017b).

3.7.2.1.5.1 Water Quality

Chemical pollution and impacts on ocean water quality are of great concern, although, its effects on marine mammals are just starting to be understood (Bachman et al., 2014; Bachman et al., 2015; Desforges et al., 2016; Foltz et al., 2014; Godard-Codding et al., 2011; Hansen et al., 2015; Jepson & Law, 2016; Law, 2014; Peterson et al., 2014; Peterson et al., 2015; Ylitalo et al., 2005; Ylitalo et al., 2009). 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).

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 (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 and can accumulate in the bodies of marine mammals and be transferred to their young through mother's milk (Fair et al., 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., 2014; Peterson et al., 2015). 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; Jepson & Law, 2016; Law, 2014).

3.7.2.1.5.2 Commercial Industries

Human impacts on marine mammals have received much attention in recent decades, and include fisheries interactions, including bycatch (accidental or incidental catch), gear entanglement, and indirect effects from takes of prey species, noise pollution; marine debris (ingestion and entanglement), hunting (both commercial and native practices), vessel strikes, entrainment into power plant water intakes, increased ocean acidification, and general habitat deterioration or destruction.

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 (Geijer & Read, 2013; Hamer et al., 2010; Northridge, 2009; Read, 2008). In 1994, the MMPA was amended to formally address bycatch. 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 (National Marine Fisheries Service, 2016h).

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. In the Hawaii portion of the Study Area, bycatch has contributed substantially to the decline of the Hawaiian population of false killer whales (Oleson et al., 2010). Between 2008 and 2012, 27 known instances of false killer whale injury or mortality from bycatch were observed during Hawaii longline fishery activities as well as similar cases for 11 other species (Bradford & Forney, 2014; Bradford & Lyman, 2015; Bradford & Forney, 2016; Bradford, 2018). In the Southern California portion of the Study Area, there were 36 marine mammal bycatch entanglements from civilian fishing activities off San Diego, CA from 2010 through 2014 (Carretta et al., 2016b; Carretta et al., 2017a; National Marine Fisheries Service, 2018).

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 (Bradford & Lyman, 2015; Bradford & Forney, 2016; Carretta et al., 2013b; Carretta et al., 2014; Carretta et al., 2016b; Helker et al., 2015; Muto et al., 2018; National Marine Fisheries Service, 2018; National Oceanic and Atmospheric Administration, 2017a; Saez et al., 2013). 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 and that an estimated 52 metric tons of derelict fishing gear washes onto the shallow coral reefs and shores of the Northwestern Hawaiian Islands each year (National Oceanic and Atmospheric Administration Fisheries, 2018).

In Hawaii in 2013, 14 Hawaiian monk seals were observed hooked and one was observed with an embedded fishing spear (Carretta et al., 2015). 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 (Carretta et al., 2013b). Within the Southern California portion of the Study Area, there were 50 marine mammal hook and line interactions (48 pinnipeds, 2 dolphins) reported off San Diego, CA from 2010 through 2014 (Carretta et al., 2016b). For the area off the coasts of northern California, Oregon, and Washington between 1982 and 2010, Saez et al. (2013) reported there were 272 large whales entangled in fishing gear (whales in this area of the U.S. West Coast are generally from the same stock as in the Southern California portion of the HSTT Study Area). In 2016, there were 71 cases of entangled whales reported off the coasts of Washington, Oregon, and California (National Oceanic and Atmospheric Administration, 2017a). These coasts include the range area for the stocks of whales present in the Southern California portion of the HSTT Study Area. For the identified sources of entanglement, none included Navy expended materials. Identified species entangled off the U.S. West Coast in 2015 and 2016 included humpback, gray, blue, fin and killer whales with a total of 133 entanglements in the 2-year period (National Oceanic and Atmospheric Administration, 2017a).

In waters off Southern California, Washington, and Alaska, 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., 2015; Trickey et al., 2015). 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). 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, 2015a).

The use of seal bombs has not been documented in Hawaiian waters and there is no evidence to suggest they would be used in the future. In Southern California portion of the HSTT Study Area, several fisheries including purse seine and set gillnet fisheries use seal bombs as deterrents (Baumann-Pickering et al., 2013). Based on the number of explosions recorded over the past several years in the Southern California, Washington, and Alaska, the use of seal bombs is much more prevalent than might be expected. For example, in the 7 months from May to November 2013, over 24,000 explosions identified as seal bombs were recorded at a passive acoustic monitoring site (Site "M") off Long Beach, CA approximately 10 kilometers (km) north of the Southern California portion of the HSTT Study Area (Debich et al., 2015a). Since this passive acoustic monitoring device only recorded a sample of the total time, it is reasonable to assume there were more than 24,000 seal bomb explosions in the 7-month period. By comparison, in the 12-month period from August 2012 to August 2013, there were fewer than 400 underwater explosions resulting from Navy training and testing in the entire Southern California portion of the HSTT Study Area (Baumann-Pickering et al., 2013). 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.

Noise

In some locations, especially where urban or industrial activities or commercial shipping is intense, anthropogenic noise can be a potential habitat level stressor (Dunlop, 2016; Dyndo et al., 2015; Erbe et al., 2014; Frisk, 2012; Gedamke et al., 2016; Heenehan et al., 2017; Hermannsen et al., 2014; Li et al., 2015; McKenna et al., 2012; Melcón et al., 2012; Miksis-Olds & Nichols, 2015; Nowacek et al., 2015; Pine et al., 2016; Williams et al., 2014c). Noise is of particular concern for 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 (Courbis & Timmel, 2009; Erbe, 2002; Erbe et al., 2016; Gabriele et al., 2018; Heenehan et al., 2016a; Heenehan et al., 2017; Hildebrand, 2009; Rolland et al., 2012; Tyack et al., 2011; Tyne et al., 2017; Williams et al., 2014b). 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., 2014; Erbe et al., 2016; National Research Council, 2003, 2005; Nowacek et al., 2007; Southall et al., 2009; Sullivan & Torres, 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).

Commercial vessel noise in particular is a major contributor to noise in the ocean and intensively used inland waters. Commercial shipping's contribution to ambient noise in the ocean increased by as much as 12 decibels (dB) between approximately the 1960s and 2005 (Hildebrand, 2005; McDonald et al., 2008). Frisk (2012) confirmed the trend, and reported that between 1950 and 2007 ocean noise in the 25 to 50 hertz (Hz) frequency range has increased 3.3 dB per decade, resulting in a cumulative increase of approximately 19 dB over a baseline of 52 dB. The increase in noise is associated with an increase in commercial shipping, which correlates with global economic growth (Frisk, 2012). Subsequently, Miksis-Olds and Nichols (2015) have demonstrated that the trends for low-frequency ocean sound levels no longer show a uniform increase across the globe. Redfern et al. (2017) found that shipping channels leading to and from the ports of Los Angeles and Long Beach between the Channel Islands National Marine Sanctuary and the coast 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 San Pedro Channel is at the northeastern corner of the Southern California portion of the HSTT Study Area and is where the Traffic Separation Scheme's southern entrance and exit is located for these same ports (Los Angeles and Long Beach). It can be assumed that the similar concentration of commercial vessel traffic moving through the San Pedro Channel into and out of the Southern California portion of the HSTT Study Area also impact marine mammal communication space in a similar manner as suggested for the shipping channels to the north investigated by Redfern et al. (2017).

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 air guns 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 air guns is heard as low-frequency sound, which can travel long distances and has the potential to impact marine mammals. Acoustic monitoring in Hawaii recorded seismic air gun pulses south of the Hawaiian Islands spanning the 2 weeks of monitoring between December 23, 2014 and January 10, 2015 (Klinck et al., 2016). NMFS routinely issues permits for the taking of marine mammals associated with these commercial activities. In January 2018, the Department of Interior issued a Draft Proposed Program to offer lease sales under the National Outer Continental Shelf Oil and Gas Leasing Program which includes potentially seven leases in Pacific (one in Southern California) and there are already 43 leases in producing status in Southern California Planning area, which could increase activity and also impact ocean noise levels.

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 to be 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., 2013; Ilyashenko et al., 2014; Ilyashenko & Chapham, 2014; Ilyashenko et al., 2015).

For U.S. waters, there is a provision in the MMPA that allows for subsistence harvest of marine mammals, primarily by Alaska Natives. Subsistence hunting by Russia and Alaska Natives also occurs in the North Pacific, Chukchi Sea, and Bering Sea affecting marine mammal stocks that may be present in the HSTT Study Area. For example, 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 Southern California portion of the HSTT Study Area.

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 (Currie et al., 2017a; Rockwood et al., 2017; Van der Hoop et al., 2013; Van der Hoop et al., 2015). For example, while some risk of a vessel strike exists for all the U.S. West Coast waters, 74 percent of blue whale, 82 percent of humpback whale, and 65 percent of fin whale known vessel strike mortalities occur in the shipping lanes associated with the ports of San Francisco and Los Angeles/Long Beach (Rockwood et al., 2017).

The U.S. Navy and U.S. Coast Guard have, since 1995, 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 and 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. Lammers et al. (2013) provided data showing that, from 1975 to 2011, 93 percent of witnessed (reported) collisions between humpback whales and vessels in Hawaii involved vessels other than U.S. Navy and U.S. Coast Guard vessels (characterized as "Mil/Gov"). In the five-year period of data provided by NMFS from 2007-2012 in Hawaii, there were 37 reported vessel collisions between humpback whales and vessels other than those characterized as "Military" and two attributed to the Navy (Bradford & Lyman, 2015). Within the Southern California portion of the Study Area, there were seven marine mammal vessel or boat strikes reported off San Diego, CA from 2010 through 2014 (Carretta et al., 2016b; Carretta et al., 2017b). The strikes were on two California sea lions, one fin whale, two gray whales, and two humpback whales and none of these strikes were from Navy vessels or boats (National Marine Fisheries Service, 2015f). For the U.S. West Coast between 2011 and 2015, there were a reported 65 non-Navy vessel strikes to marine mammals involving 32 pinnipeds, 28 large whales, and 5 smaller cetaceans (Carretta et al., 2017b).

Powerplant Entrainment

Coastal powerplants use seawater as a coolant during power plant operation. Intakes into these plants can sometimes trap (i.e., entrain) marine mammals that swim too close to the intake pipe. There have been no entrainments of marine mammals reported for Hawaii. Within the Southern California portion of the Study Area, there were 97 marine mammal power plant entrainments (all pinnipeds) reported from San Diego, CA between 2010 and 2014 (Carretta et al., 2016b).

3.7.2.1.5.3 Disease and Parasites

Just as in humans, disease affects marine mammal health and especially older animals. For example, the necropsy of a false killer whale found stranded on Hawaii Island in November 2015 concluded that the animal died as the result of a blood clot, which can be caused by infections, chronic heart disease, or cancer (Pascual, 2015). The first case of morbillivirus (a virus related to measles in humans) in the central Pacific was documented for a stranded juvenile male Longman's beaked whale discovered in 2010 on the Island of Maui in Hawaii (West et al., 2012; West et al., 2015) and subsequently in 2011 brucella (a bacterial pathogen) and morbillivirus were discovered in a sperm whale that stranded on Oahu (West et al., 2015). In 2015, the Hawaiian Monk Seal Research Program (HMSRP) began a vaccination program to protect Hawaiian monk seals from morbillivirus (National Oceanic and Atmospheric Administration, 2015b). 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 2000–2015 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). 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).

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, thereby accumulating fatal doses. An example is domoic acid poisoning in California sea lions and northern fur seals from the diatom *Pseudo-nitzschia* spp. (Doucette et al., 2006; Fire et al., 2008; Lefebvre et al., 2010; Lefebvre et al., 2016; Torres de la Riva et al., 2009). A comprehensive study in Alaska that sampled over 900 marine mammals across 13 species, including several mysticetes, odontocetes, pinnipeds, and mustelids, 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 30 whales found around the islands in the western Gulf of Alaska and the southern shoreline of the Alaska Peninsula starting in May 2015 (National Oceanic and Atmospheric Administration, 2016; Rosen, 2015; Savage et al., 2017; Summers, 2017). These findings from studies in Alaska are relevant to the HSTT Study Area given that whales from stocks in both the Hawaii and the Southern California portions of the HSTT Study Area migrate to Alaska 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; Ten Doeschate et al., 2017). The HMSRP reported that in Hawaii since 2001, there have been at least 8 deaths of Hawaiian monk seals attributed to parasitic toxoplasmosis from feral cats in the main Hawaiian Islands (Hawaiian Monk Seal Research Program, 2015). Toxoplasmosis has also been found in two spinner dolphins (Barbieri et al., 2017; Rogers, 2016). In California this same parasite also impacts seals, sea lions, and sea otters. The most commonly reported parasitic infections were from protozoans in sea otters; other parasites known to cause disease in pinnipeds and sea otters include hookworms, lungworms, and thorny-headed worms (Simeone et al., 2015).

3.7.2.1.5.4 Invasive Species

There are no known current threats to marine mammals from invasive species in the Study Area.

3.7.2.1.5.5 Climate Change

The global climate is warming and is having impacts on some populations of marine mammals (Garcia-Aguilar et al., 2018; Jefferson & Schulman-Janiger, 2018; National Oceanic and Atmospheric Administration, 2015c, 2018b; Peterson et al., 2006; Salvadeo et al., 2010; Shirasago-Germán et al., 2015; Silber et al., 2017; Simmonds & Eliott, 2009). Climate change can affect marine mammal species directly by causing shifts in distribution to match physiological tolerance under changing environmental conditions (Doney et al., 2012; Peterson et al., 2006; Silber et al., 2017), which may or may not result in net habitat loss (some can experience habitat gains). 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; Peterson et al., 2006). In more northern latitudes, the loss of sea ice and changing ice habitat are impacting marine mammals that are dependent on ice for resting, foraging and reproduction (Jay et al., 2012; Laidre et al., 2015). 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, including San Diego County. Additional California counties experiencing elevated California sea lion strandings include Santa Barbara County, Ventura County, Los Angeles County, and Orange County. This unusual number of strandings, continuing into 2016, were declared an Unusual Mortality Event by NMFS (National Oceanic and Atmospheric Administration, 2018a, 2018b). Although this Unusual Mortality Event was still considered as “ongoing” through 2017, the number of strandings recorded in 2017 were at or below average (National Oceanic and Atmospheric Administration, 2018a). This is the sixth Unusual Mortality Event involving California sea lions that has occurred in California since 1991. For this 2013–2015 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 for their pups (National Oceanic and Atmospheric Administration, 2018a). As a result, this confluence of natural events causes the pups to leave the rookeries on their own, and many are subsequently found stranded dead or emaciated due to starvation. In 2015, 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 Oceanic and Atmospheric Administration, 2018b). This event continued into 2017 although the number of animals involved declined in 2017; in April 2017 an additional seven Guadalupe fur seals stranded associated with this Unusual Mortality Event. The assumed cause for the increase in strandings is the change in the prey base due to warming conditions (National Oceanic and Atmospheric Administration, 2015c, 2018b).

Likely also due to changing prey distributions, data tagging efforts in July 2016 focusing on blue and fin whales had to be shifted north to Central California waters when the majority of blue, fin, and humpback whales encountered in Southern California waters were found to be too thin or otherwise in poor body condition to allow for them to be tagged (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 that season (Oregon State University, 2017).

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 et al., 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. Most of the mysticetes found in the HSTT Study Area spend part of the year in the North Pacific. 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).

Climate change may indirectly influence marine mammals through changes in human behavior, such as increased shipping and oil and gas extraction, which benefit from sea ice loss (Alter et al., 2010). Ultimately impacts from global climate change may result in an intensification of current and on-going threats to marine mammals (Edwards, 2013). In addition, the ability of marine mammals to alter behaviors may serve as a buffer against measurable climate change–induced impacts and could delay or mask any adverse effects until critical thresholds are reached (Baker et al., 2016a).

Marine mammals are influenced 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. Generally, not much is known about how large storms and other weather patterns affect marine mammals, other than that mass strandings (when two or more marine mammals become beached or stuck in shallow water) sometimes coincide with hurricanes, typhoons, and other tropical storms (Bradshaw et al., 2006; Marsh, 1989; Rosel & Watts, 2008), or other oceanographic conditions. There have also been correlations in time and space between strandings and the occurrence of earthquakes. However, there has been no scientific investigation demonstrating evidence for or against a relationship between earthquakes and the occurrence of marine mammal strandings. Indirect impacts may include altered water chemistry in estuaries (low dissolved oxygen or increased nutrient loading) causing massive fish kills (Burkholder et al., 2004) changing prey distribution and availability for cetaceans (Stevens et al., 2006). Human responses to extreme weather events may indirectly affect behavior and reproductive rates of marine mammals. For example, Miller et al. (2010) reported an increase in reproductive rates in bottlenose dolphins after Hurricane Katrina in the Mississippi Sound, presumably resulting from an increase in fish abundance due to a reduction in fisheries landings, a decrease in recreational and commercial boat activities (National Marine Fisheries Service, 2007e), and an increase in the number of reproductively active females available during the breeding seasons following the storm. Smith et al. (2013) supplemented the findings from this study and documented a marked increase in foraging activity in newly identified foraging areas that were observed during the two-year study period after the storm.

Habitat deterioration and loss is a major factor for almost all coastal and inshore species of marine mammals, with effects ranging from 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; Silber et al., 2017; Sydeman & Allen, 1999). Poloczanska et al. (2016) analyzed climate change impact data that integrates multiple climate influenced changes in ocean conditions (i.e., temperature, acidification, dissolved oxygen, and rainfall) to assess anticipated changes to a number of key ocean fauna across representative areas. In relation to the HSTT 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.

3.7.2.1.5.6 Marine Debris

Marine debris is a global threat to marine mammals (National Oceanic and Atmospheric Administration Marine Debris Program, 2014b). Since 1996, NOAA has removed 848 metric tons of derelict fishing nets and debris from the Northwest Hawaiian Islands and has estimated that an additional 52 tons of debris collects on the shallow coral reefs and shores there every year (National Oceanic and Atmospheric Administration Fisheries, 2018). A literature review by Baulch and Perry (2014), found that 56 percent of cetacean species are documented as having ingested marine debris. Interactions between marine mammals and marine debris, including derelict fishing gear and plastics, are significant sources of injury and mortality (Baulch & Perry, 2014). 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; Puig-Lozano et al., 2018), pygmy sperm whales (Sadove & Morreale, 1989; Stamper et al., 2006; Tarpley & Marwitz, 1993), and sperm whales (Jacobsen et al., 2010; Sadove & Morreale, 1989).

From April 2013 to April 2016 in the waters around Lanai and channels between Lanai, Maui, and Kahoolawe, surveys were conducted to quantify the presence of marine mammals and floating marine debris (Currie et al., 2017b). The surveys encountered, collected, and categorized 1,027 pieces of marine debris. Items categorized as "plastic" were the predominant type of debris encountered, accounted for 86 percent of total debris, and consisted mainly of plastic bottles, tubs, baskets, foamed polystyrene disposable plates, cups, and fragments, plastic bags, and other soft plastic films. A smaller portion of the plastic debris (13 percent; 11 percent of the total debris) were fishing-related and included items such as buoys, netting, rope, and fishing lines. Milled lumber and rubber accounted for 10 percent of debris, with the remaining 4 percent attributed to metal, glass, and clothing/fabric.

For cetaceans in Hawaii during the five-year period between 2007 and 2012, there were 48 humpback whales, a sperm whale, a bottlenose dolphin, 3 spinner dolphins, and a pantropical spotted dolphin entangled in marine debris (Bradford & Lyman, 2015). One humpback whale was known to be injured, and it is believed that interaction with debris led to the mortality of a second humpback whale and a spinner dolphin (Bradford & Lyman, 2015). Over the 30-year period between 1982 and 2012, approximately 11 Hawaiian monk seals annually have been observed entangled in fishing gear or other marine debris, with nine documented deaths (Carretta et al., 2015). Marine mammals migrating from Hawaii and Southern California to Alaska also encounter threats outside the HSTT Study Area. In Alaska from 2011 through 2015, records of approximately 3,700 human-marine mammal interactions were reviewed by NMFS and those interactions were determined to have resulted in 440 entanglement/entrapment-related marine mammal serious injuries or mortalities to various species

(Helker et al., 2017). It should be noted that NMFS does not consider an entanglement a serious injury unless it leads to the death of the animal. For example, a gray whale entangled in a gillnet and rope in 2009 was resighted while still entangled in 2011, and then resighted free of fishing gear in 2013; since it was in apparent good health, the final NMFS injury determination for the case was non-serious (Carretta et al., 2017b).

On the U.S. West Coast from 2010 to 2015 for the marine mammal stocks that are present in the Southern California portion of the HSTT Study Area, marine debris resulted in mortalities to 104 pinnipeds (mostly California sea lions), two gray whales, and one each of the following species: humpback whale, minke whale, bottlenose dolphin, and long-beaked common dolphin (Carretta et al., 2016b; Carretta et al., 2017b). From 2010 through 2014, within the Southern California portion of the Study Area, there were six marine mammal entanglements (one blue whale, four pinnipeds, two dolphins) from marine debris reported off San Diego, CA (Carretta et al., 2016b). In a seafloor survey off Southern California including the HSTT Study Area, urban refuse (beverage cans, bottles, household items, and construction materials) constituted approximately 88 percent of the identified debris observed (Watters et al., 2010). Marine debris documented off the Mexican Central Pacific coast (Díaz-Torres et al., 2016) also have the potential to impact marine mammals that migrate through Mexican waters to the Southern California portion of the HSTT Study Area, such as the ESA-listed humpback whale distinct population segments from Mexico and Central America.

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). Plastic pollution found in the oceans is primarily dominated by particles smaller than 1 centimeter (cm), commonly referred to as microplastics (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 62–5000 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 HSTT 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 mm to 17 cm. There is still a large knowledge gap about possible negative effects of microplastics but it remains a concern (Besseling et al., 2015). 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).

Marine mammals as a whole are subject to the various influences and factors delineated in this section. If specific threats to individual species in the Study Area are known, those threats are described below in individual species accounts.

3.7.2.2 Endangered Species Act-Listed Species

As shown in Table 3.7-1, the 10 marine mammal species and applicable stocks listed under the ESA and occurring within the Study Area are the humpback whale (Mexico Distinct Population Segment and the Central America Distinct Population Segment), blue whale, fin whale, sei whale, gray whale (Western North Pacific stock), sperm whale, false killer whale (main Hawaiian Islands Insular stock), Guadalupe fur seal, Hawaiian monk seal, and southern sea otter. The following subsections provide detailed species descriptions, including status, habitat ranges, population trends, predator/prey interactions, and species specific threats.

3.7.2.2.1 Humpback Whale (*Megaptera novaeangliae*), Mexico Distinct Population Segment and Central America Distinct Population Segment

Humpback whales that are seasonally present in the HSTT Study Area are from three Distinct Population Segments given they represent populations that are both discrete from other conspecific populations and significant to the species of humpback whales to which they belong (National Marine Fisheries Service, 2016f). These Distinct Population Segments that are based on animals identified in breeding areas in Hawaii, Mexico, and Central America (Bettridge et al., 2015; Calambokidis et al., 2017; Carretta et al., 2017c; Carretta et al., 2018a; Muto et al., 2017a; National Marine Fisheries Service, 2016c; Wade et al., 2016). Discussion of the Hawaii Distinct Population Segment that is seasonally present in the Hawaii portion of the HSTT Study Area and which is not listed under the ESA is presented in Section 3.7.2.3.1 (Humpback Whale [*Megaptera novaeangliae*]), Hawaii Distinct Population Segment). Presentation of information is provided in the following subsections for the Mexico Distinct Population Segment and the Central America Distinct Population Segment, which are both seasonally present in the Southern California portion of the HSTT Study Area.

3.7.2.2.1.1 Status and Management

Humpback whales of the Mexico Distinct Population Segment are listed as threatened and those from the Central America Distinct Population Segment are listed as endangered under the ESA (National Marine Fisheries Service, 2016f). Together these two Distinct Population Segments, plus a small number of whales from the non-listed Hawaii Distinct Population Segment, are considered the California, Oregon, and Washington stock of humpback whales and are listed as depleted under the MMPA (Carretta et al., 2017c; Carretta et al., 2017d; Carretta et al., 2018b; National Marine Fisheries Service, 2016f). The California, Oregon, Washington stock of humpback whales is present in the Southern California portion of the HSTT Study Area as they migrate northward from their winter breeding grounds in Mexico and Central America and then again when migrating southward in their return from feeding areas along the U.S West Coast, British Colombia, and Alaska (Calambokidis et al., 2017; Carretta et al., 2018b). There is also an overlap of the Mexico Distinct Population Segment and the Western North Pacific Distinct Population Segment as demonstrated by 11 documented matches of whales from Mexico found in the feeding grounds off Russia (Titova et al., 2017).

3.7.2.2.1.2 Habitat and Geographic Range

The habitat requirements of wintering humpbacks appear to be controlled by the conditions necessary for calving, such as warm water (75 to 80° Fahrenheit [24° to 28° Celsius]) and relatively shallow, low-relief ocean bottom in protected areas, nearshore or created by islands or reefs (Clapham, 2000; Craig & Herman, 2000; Smultea, 1994). In breeding grounds, females with calves occur in significantly shallower waters than other groups of whales, and breeding adults use deeper more offshore waters (Ersts & Rosenbaum, 2003; Smultea, 1994). Breeding and calving areas for the Mexico Distinct Population

Segment and for the Central America Distinct Population Segment are both located far to the south of the Southern California portion of the HSTT Study Area.

Off the U.S. West Coast, humpback whales are more abundant in shelf and slope waters (<2,000 meters [m] deep), and are often associated with areas of high productivity (Becker et al., 2010; Becker et al., 2012a; Becker et al., 2016; Forney et al., 2012; Redfern et al., 2013). While most humpback whale sightings are in nearshore and continental shelf waters, humpback whales frequently travel through deep oceanic waters during migration (Calambokidis et al., 2001; Clapham & Mattila, 1990; Clapham, 2000; Mate et al., 1998). Humpback whales migrating from breeding grounds in Mexico and Central America on their way to feeding grounds at higher latitudes may cross the Southern California portion of the HSTT Study Area including the Transit Corridor located farther offshore.

Humpback migrations are complex and cover long distances (Barlow et al., 2011; Calambokidis et al., 2009b; Mate et al., 1998). The California, Oregon, and Washington stock of humpback whales may use the waters within the Southern California portion of the Study Area as a summer feeding ground. While most humpback whales migrate, data from surveys conducted between 2004 and 2013 show that humpback whales occur year-round off southern California (Campbell et al., 2015). Peak occurrence during migration occurs in the Southern California portion of the Study Area from December through June (Calambokidis et al., 2015). During late summer, more humpback whales are sighted north of the Channel Islands, and limited occurrence is expected south of the northern Channel Islands (San Miguel, Santa Rosa, Santa Cruz) (Carretta et al., 2010). Based on aerial survey data collected between 2008 and 2012 in the Southern California portion of the HSTT Study Area, Smultea and Jefferson (2014) determined that humpback whales ranked eighth in relative occurrence of cetaceans and concluded that this species has clearly increased their representation in the Navy's Southern California range complex over the last several decades.

The wintering areas for the Mexico Distinct Population Segment are the waters and islands off Mexico and for the Central America Distinct Population Segment, the wintering areas are waters from southern Mexico and south along the coast of Central America (Calambokidis et al., 2008). There have been no identified biologically important areas for humpback whales in the Southern California portion of the HSTT Study Area (Calambokidis et al., 2015).

3.7.2.2.1.3 Population Trends

Although recent estimates show variable trends in the number of humpback whales along the U.S. West Coast, the overall trend in the estimates is consistent with a growth rate of 6 to 7 percent for the California, Oregon, Washington stock and appear consistent with the highest-yet abundances of humpback whales in the most recent 2014 surveys of that stock (Barlow, 2016; Calambokidis et al., 2017; Carretta et al., 2017c; Carretta et al., 2018b; Smultea, 2014) and the increasing presence in Puget Sound, Washington (Calambokidis et al., 2017). For the distinct population segments in Mexico and Central America, photo-identification data collected between 2004 to 2006 are the main basis for the estimates for those populations (Bettridge et al., 2015; National Marine Fisheries Service, 2016f; Wade et al., 2016), however, because the data are greater than 8-years old, they do not provide for reliable estimates of the current abundances (Carretta et al., 2018b). There are no population trend data for the Mexico Distinct Population Segment or the Central America Distinct Population Segment since there have been no subsequent data collected for comparison (Bettridge et al., 2015; Carretta et al., 2018b; National Marine Fisheries Service, 2016f; Wade et al., 2016).

3.7.2.2.1.4 Predator and Prey Interactions

Within the Southern California feeding grounds, humpback whales feed on a wide variety of invertebrates and small schooling fishes. The most common invertebrate prey are krill (tiny crustaceans); the most common fish prey are herring, mackerel, sand lance, sardines, anchovies, and capelin (Clapham & Mead, 1999). Feeding occurs both at the surface and in deeper waters, wherever prey is abundant. Humpback whales are the only species of baleen whale that shows strong evidence of cooperation when they feed in large groups (D'Vincent et al., 1985).

Humpback whales are known to be attacked by both killer whales and false killer whales as evidenced by tooth rake scars on their bodies and fins (Jefferson et al., 2015). Photographs of humpback whales with rake mark scarring taken at 16 wintering or feeding areas across the north Pacific were used to determine that a substantial portion of animals had been attacked; the highest rates documented were for whales that migrate between California and Mexico (Steiger et al., 2008).

3.7.2.2.1.5 Species-Specific Threats

Entanglement in pot/trap fisheries has been the most common source of injury to humpback whales along the U.S. Pacific coast (Carretta et al., 2016b; Carretta et al., 2017d; National Oceanic and Atmospheric Administration, 2017a; Saez et al., 2012). There were 54 separate entanglement cases reported for humpback whales along the U.S West Coast in 2016 (National Oceanic and Atmospheric Administration, 2017a). For the five-year period between 2011 and 2015 there were 34 cases of entanglement involving pot/trap fisheries and an additional 26 cases of reported interactions with other fisheries (Carretta et al., 2017d). Humpback whales from Mexico and Central America have been identified feeding in Alaska (Bettridge et al., 2015; Calambokidis et al., 2008). Humpback whales have also been reported seriously injured and killed from entanglement in fishing gear while in their Alaskan feeding grounds (Helker et al., 2017); some proportion of these entanglements could be to be whales from the Mexico Distinct Population Segment and from the Central America Distinct Population Segment. An overall minimum estimate of mortality and serious injury due to fisheries in Alaska is 14 humpback whales annually (Muto et al., 2017a).

Available data from NMFS indicate that along the U.S. Pacific coast between 2011 and 2015, there were nine ship strikes involving humpback whales; none were Navy vessels (Carretta et al., 2016b; Carretta et al., 2017b). The mean vessel collision mortality and serious injury rate in Alaska is 4.3 humpback whales annually (Muto et al., 2017a).

Humpback whales are also potentially affected by loss of habitat, loss of prey (for a variety of reasons including climate variability), underwater noise, jet skis and similar fast waterborne tourist-related traffic disturbance and vessel strike, and pollutants (Muto et al., 2017a). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.2.2 Blue Whale (*Balaenoptera musculus*)

3.7.2.2.2.1 Status and Management

The world's population of blue whales can be separated into three subspecies, based on geographic location and some morphological differences. In the HSTT Study Area, the subspecies *Balaenoptera musculus* is present. The blue whale is listed as endangered under the ESA and as depleted under the MMPA throughout its range, but there is no designated critical habitat for this species (Carretta et al., 2018a; Muto et al., 2017b).

3.7.2.2.2.2 Habitat and Geographic Range

Blue whales inhabit all oceans and typically occur near the coast and over the continental shelf, though they are also found in oceanic waters, having been sighted, acoustically recorded, and satellite tagged in the eastern tropical Pacific (Ferguson, 2005; Stafford et al., 2004).

Blue whales from the Central North Pacific stock are found in the Hawaii portion of the Study Area, but the sighting frequency is low and the peak abundance is seasonal, occurring in the winter (Bradford et al., 2013). Whales feeding along the Aleutian Islands and in the Gulf of Alaska likely migrate to Hawaii in winter (Stafford et al., 2001). In the winter of 2014–2015 (December to January), passive acoustic detections of blue whales were recorded intermittently over the three-week period of the survey (Klinck et al., 2015).

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., 2017c; Carretta et al., 2018b). 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 blue whales are predicted off southern California during the summer and fall (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2016; Forney et al., 2012). Data from year-round surveys conducted off southern California from 2004 to 2013 show that the majority of blue whales were sighted in summer (62 sightings) and fall (9 sightings), with only single sightings in winter and spring (Campbell et al., 2015). In the Southern California Bight in summer and fall, the highest densities of blue whales occurred along the 200-m isobath in waters with high surface chlorophyll concentrations (Redfern et al., 2013). Campbell et al. (2015) documented blue whale sightings along both the Southern California shelf and over deep ocean water (>2,000 meters [m]). This species has also frequently been heard on passive acoustic recording devices in the Southern California portion of the Study Area (Lewis & Širović, 2018; Širović et al., 2015b). Based on approximately 3 million detections in the waters of the Southern California Bight between 2006 and 2012, Širović et al. (2015b) found that blue whale vocalizations were more common at coastal sites and near the northern Channel Islands and generally heard between June and January, with a peak in September. There was large variation among blue whales tagged in the Southern California portion of the HSTT Study Area with the distance to shore ranging from less than 1 km and up to 884.8 km and blue whale movement along the Pacific coastline extending south to just 7.4 degrees north latitude (just north of the equator and north to 50 degrees north latitude just off British Colombia, Canada (Mate et al., 2015b). Tagging data from blue whales in Southern California waters indicate the area of highest use for blue whales was between Point Dume and Mugu Canyon (north of the HSTT Study Area), out to approximately 30 km from shore (Mate et al., 2015b).

Most blue whale sightings are in nearshore and continental shelf waters; however, blue whales frequently travel through deep oceanic waters during migration (Širović et al., 2004). Most baleen whales 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; Calambokidis et al., 2009a; Calambokidis et al., 2009b; Mate et al., 2015b; Mate et al., 2016). The West Coast is known to be a blue whale feeding area for the Eastern North Pacific stock during summer and fall (Bailey et al., 2009; Calambokidis et al., 2009a; Calambokidis et al., 2015; Mate et al., 2015b). Photographs of blue whales off California that have been matched to individuals photographed off the Queen Charlotte Islands in northern British Columbia and the northern Gulf of Alaska (Calambokidis et al., 2009a) and satellite tag data have also demonstrated this link between these areas (Mate et al., 2015b). These animals have shown site fidelity, returning to their mother's feeding grounds on their first migration (Calambokidis & Barlow, 2004).

There have been nine feeding areas identified for blue whales off the U.S. West Coast (Calambokidis et al., 2015). Of these nine, only four overlap with the HSTT Study Area. Two of these feeding areas (the Santa Monica Bay to Long Beach feeding area and the San Nicolas Island feeding area) are at the extreme northern edge of and slightly overlap with the Southern California portion of the HSTT Study Area. The remaining two feeding areas (the Tanner-Cortes Bank and the San Diego feeding areas are entirely within the HSTT Study Area; see Calambokidis et al. (2015)). The feeding behavior for which these areas are designated occurs from June to October (Aquatic Mammals, 2015a; Calambokidis et al., 2015). The blue whale feeding areas identified in waters extending from Point Conception to the Mexico border represent only a fraction of the total area within those waters where habitat models predict high densities of blue whales (Calambokidis et al., 2015). Additionally, while those habitat models represent the areas tending to have the highest blue whale density when averaged over many years, the individual areas may not reflect the actual density present in any one given season or shorter time period considered. For example, tagging efforts in July 2016 focusing on blue and fin whales 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 in that season (Oregon State University, 2017). Appendix K (Geographic Mitigation Assessment) provides a detailed analysis of the potential effects of Navy training and testing on the identified blue whale feeding area.

3.7.2.2.2.3 Population Trends

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 at its lowest point (Branch, 2007; Monnahan, 2013; Monnahan et al., 2014; Rocha et al., 2014; Širović et al., 2004). Off the Pacific Coast, there was a documented increase in the blue whale population size between 1979–80 and 1991 (Barlow, 1994) and between 1991 and 1996 (Barlow, 1997). Based on subsequent line-transect surveys conducted off the Pacific Coast between 2001 and 2005, the abundance estimates of blue whales appeared to decline in those waters over the survey period (Barlow & Forney, 2007). However, this apparent decline 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, 2010; Calambokidis et al., 2009a; Carretta et al., 2018b). 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. In 2005–2006, during a period of cooler ocean temperatures, blue whales were found distributed more widely throughout southern California waters than in previous years (Peterson et al., 2006). A comparison of survey data from the 1990s to 2014 indicated that there had been a northward shift in blue whale distribution within waters off California, Oregon, and Washington (Barlow, 2010, 2016; Širović et al., 2015b). Consistent with the earlier suggested variability in the distribution patterns, Carretta et al. (2013a) report that blue whales from the U.S. West Coast have been increasingly found feeding to the north and south of the U.S. West Coast during summer and fall. Subsequent mark-recapture estimates reported on 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 in the Pacific (see also Calambokidis and Barlow (2013)).

The most current information suggests that the population in the HSTT Study Area may have recovered and has been at a stable level following the cessation of commercial whaling in 1971, despite the impacts of ship strikes, interactions with fishing gear, and increased levels of ambient sound in the Pacific Ocean (Campbell et al., 2015; Carretta et al., 2015; Monnahan, 2013; Monnahan et al., 2014; Širović et al., 2015b). Based on a comparison of sighting records from the 1950s to 2012 in the Southern California portion of the HSTT Study Area, Smultea (2014) determined that blue whales ranked sixth in occurrence among cetaceans which, "… represents a clear relative increase from historical records".

3.7.2.2.2.4 Predator and Prey Interactions

Blue whales feed almost exclusively on various types of zooplankton, especially krill (Jefferson et al., 2015), however, it has recently been shown that blue whales can locate and feed on dense swarms of other larger prey when present (De Vos et al., 2018). In Southern California, tagged blue whales have been recorded feeding from the surface to depths approaching 300 m (Goldbogen et al., 2013).

Blue whales have been documented to be preyed on by killer whales and 25 percent of photo-identified whales in the Gulf of California carry rake scars from killer whale attacks (Jefferson et al., 2008b; Pitman et al., 2007; Sears & Perrin, 2009).

3.7.2.2.2.5 Species-Specific Threats

Blue whales are susceptible to entanglement in fishing gear and ship strikes (Carretta et al., 2018b). A seriously injured blue whale was sighted entangled in unidentified pot/trap gear offshore of southern California in 2015 (Carretta et al., 2017b). There have been no Navy vessel strikes to blue whales in at least the last 13 years (Carretta et al., 2017b; National Marine Fisheries Service, 2015f). Available data from NMFS indicate that, in waters off California between 1991 and 2010, there were 14 ship strikes involving blue whales (Berman-Kowalewski et al., 2010; Calambokidis et al., 2009a; Calambokidis, 2012; Laggner, 2009; Monnahan et al., 2015; National Marine Fisheries Service, 2011c). Between 2007 and 2011 in waters of the U.S. West Coast, 10 blue whales died from vessel strikes (Carretta, 2013; Carretta et al., 2016b). Blue whale mortality and injuries attributed to ship strikes in California waters were zero in the reporting period covering 2011–2015, but there was one non-Navy blue whale ship strike death reported in 2016 (Carretta et al., 2017b; Carretta et al., 2018b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.2.3 Fin Whale (*Balaenoptera physalus*)

3.7.2.2.3.1 Status and Management

The fin whale is listed as depleted under the MMPA and endangered under the ESA throughout its range, 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 whale were taken by industrialized whaling than any other species (Rocha et al., 2014). In the North Pacific, NMFS recognizes three fin whale stocks: (1) a Northeast Pacific stock in Alaska; (2) a California, Oregon, and Washington stock; and (3) a Hawaii stock. Although some fin whales migrate seasonally (Falcone et al., 2011; Mate et al., 2015b; Mate et al., 2016), NMFS does not recognize fin whales from the Northeast Pacific stock as being present in either Hawaii or Southern California.

3.7.2.2.3.2 Habitat and Geographic Range

The fin whale is found in all the world's oceans and is the second largest species of whale (Jefferson et al., 2015). Fin whales prefer temperate and polar waters and are scarcely seen in warm, tropical waters (Reeves et al., 2002a).

Fin whales are found in Hawaiian waters, but this species is considered to be rare in this portion of the Study Area (Carretta et al., 2010; Shallenberger, 1981). There are known sightings from Kauai, Oahu, Hawaii and a single stranding record from Maui (Mobley et al., 1996; Shallenberger, 1981; U.S. Department of the Navy, 2011b). A single sighting was made during aerial surveys from 1993 to 1998, five sightings were made in offshore waters during a 2002 survey of waters within the Hawaiian Exclusive Economic Zone, and there were 2 fin whales sighted during a 2010 survey of the same area (Barlow, 2006; Bradford et al., 2017; Carretta et al., 2010; Mobley et al., 1996; Mobley et al., 2009). A single juvenile fin whale was reported off Kauai during Navy-sponsored marine mammal research in 2010 (U.S. Department of the Navy, 2011b). Based on sighting data and acoustic recordings, fin whales are likely to occur in Hawaiian waters mainly in fall and winter (Barlow et al., 2004; Barlow, 2006; Barlow et al., 2008; Klinck et al., 2015).

This species has been documented from 60° North (N) to 23° N. Fin whales have frequently been recorded in waters within the Southern California portion of the Study Area and are present year-round (Barlow & Forney, 2007; Campbell et al., 2015; Jefferson et al., 2014; Mate et al., 2016, 2017; Mizroch et al., 2009; Širović et al., 2004; Širović et al., 2015b; Širović et al., 2016; Širović et al., 2017; Smultea, 2014). As demonstrated by satellite tags and discovery tags[2], fin whales make long-range movements along the entire U.S. West Coast (Falcone et al., 2011; Mate et al., 2015b; Mizroch et al., 2009). However, photo-identification studies of fin whales off the U.S. West Coast suggest that not all fin whales undergo long-range seasonal migrations, but instead make short-range seasonal movements in spring and fall (Falcone et al., 2011; Falcone & Schorr, 2011). Six tags were deployed on fin whales in the Southern California portion of the HSTT Study Area in August 2014 (Mate et al., 2015b). The movements of these whales were highly variable, ranging from less than 1 km to approximately 232 km from the California coast, a core area generally north of the Southern California portion of HSTT Study Area, and moving as far north as the Oregon border with California and as far south as Central Baja Mexico (Mate et al., 2015b). Fin whales are not known to have a specific habitat and are highly adaptable, following prey, typically off the continental shelf (Azzellino et al., 2008; Panigada et al., 2008; Scales et al., 2017). Off the U.S. West Coast, fin whales typically congregate in areas of high productivity, allowing for extended periods of localized residency that are not consistent with the general baleen whale migration model (Scales et al., 2017).

Based on predictive habitat-based density models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast, relatively high densities of fin whales are predicted off southern California during the summer and fall (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012a; Becker et al., 2016; Forney et al., 2012). Aggregations of fin whales are present year-round in southern and central California (Campbell et al., 2015; Douglas et al., 2014; Forney et al., 1995; Forney & Barlow, 1998; Jefferson et al., 2014; Scales et al., 2017), although their distribution shows seasonal shifts. In 2005–2006, during a period of cooler ocean temperatures, fin whales were encountered more

[2] 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.

frequently than during nominal years (Peterson et al., 2006). Sightings from year-round surveys off southern California from 2004 to 2013 show fin whales farther offshore in summer and fall and closer to shore in winter and spring (Campbell et al., 2015; Douglas et al., 2014).

As was done for other species, a scientific review process (Ferguson et al., 2015) was undertaken to identify biologically important areas for fin whales occurring along the U.S. West Coast. Survey and acoustic data indicates that fin whale distributions shift both seasonally as well as annually (Calambokidis et al., 2015; Douglas et al., 2014; Jefferson et al., 2014; Peterson et al., 2006; Širović et al., 2015b; Širović et al., 2017). Using available quantitative density and distribution mapping, the best available science, and expert elicitation, definitive areas of importance for fin whales could not be determined (Calambokidis et al., 2015).

3.7.2.2.3.3 Population Trends

For Hawaii, NMFS has determined that an assessment of the fin whale population trend will likely require additional survey data and reanalysis of all datasets using comparable methods (Carretta et al., 2017d).

For California, Moore and Barlow (2011) predict continued increases in fin whale numbers over the next decade, and suggest that fin whale densities are reaching "current ecosystem limits." Based on a comparison of sighting records from the 1950s to 2012, Smultea and Jefferson (2014) also showed an increase in the relative abundance of fin whales inhabiting the Southern California portion of the HSTT Study Area. Širović et al. (2015b) used passive acoustic monitoring of fin whale calls to estimate the spatial and seasonal distribution of fin whales in the Southern California Bight. An increase in the number of calls detected between 2006 and 2012 also suggests that the population of fin whales off the U.S. West Coast may be increasing. Based on 18 aerial surveys conducted between 2008 and 2013, fin whales were one of the most common large whales in the Southern California portion of the HSTT Study Area (Jefferson et al., 2014). Increasing numbers of fin whales documented in coastal waters between Vancouver Island and Washington State may reflect recovery of populations in the North Pacific (Towers et al., 2018). These findings and the trend for an increase in population, appear consistent with the highest-yet abundances of fin whales in the most recent 2014 NMFS survey of the U.S. West Coast (Barlow, 2016).

3.7.2.2.3.4 Predator and Prey Interactions

This species preys on small invertebrates such as copepods as well as squid and schooling fishes, such as capelin, herring, and mackerel (Goldbogen et al., 2006; Jefferson et al., 2008a). The fin whale is not known to have a significant number of predators. However, in regions where killer whales are abundant, some fin whales exhibit attack scars on their flippers, flukes, and flanks, suggesting predation by killer whales (Aguilar, 2009).

3.7.2.2.3.5 Species-Specific Threats

Fin whales are susceptible to both ship strikes and entanglement in fishing gear (Carretta et al., 2018b). Available data from NMFS indicate that, in waters off California between 1991 and 2010, there were 11 reported ship strikes involving fin whales (National Marine Fisheries Service, 2011c) and from 2010 to 2014 along the U.S West Coast there were 9 reported ship strikes to fin whales (Carretta et al., 2016b). In the HSTT Study Area for the 10-year period from 2007-2016, there were only two Navy ship strikes and both of these involved fin whales in Southern California in 2009. Between 2011 and 2015, one fin whale was observed entangled in long-line fishing gear in Hawaii (Carretta et al., 2017d). Based on reports from 2007 to 2014 for waters off the U.S. West Coast, a total of 4 fin whales were seriously injured by entanglement in fishing gear (Carretta et al., 2013b; Carretta et al., 2016b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.2.4 Sei Whale (*Balaenoptera borealis*)

3.7.2.2.4.1 Status and Management

The sei whale is listed as endangered under the ESA and as depleted under the MMPA throughout its range, but there is no designated critical habitat for this species. A recovery plan for the sei whale was completed in 2011 and provides a research strategy for obtaining data required to estimate population abundance and trends, and to identify factors that may be limiting the recovery of this species (National Marine Fisheries Service, 2011e). Sei whales in Hawaii are assigned to the Hawaii stock and along the U.S. West Coast, the Eastern North Pacific stock is recognized within the U.S. Exclusive Economic Zone including the Southern California portion of the HSTT Study Area (Carretta et al., 2017c; Carretta et al., 2018a, 2018b).

3.7.2.2.4.2 Habitat and Geographic Range

Sei whales have a worldwide distribution and are found primarily in cold temperate to subpolar latitudes. During the winter, sei whales are found in warm tropical waters like those around Hawaii. Sei whales are also encountered during the summer off California and the North America coast from approximately the latitude of the Mexican border to as far north as Vancouver Island, Canada (Horwood, 2009; Masaki, 1976, 1977; Smultea et al., 2010). Although sei whales have been observed south of 20° N in the winter (Fulling et al., 2011; Horwood, 2009; Horwood, 1987), they are considered absent or at very low densities in most equatorial areas. Whaling data provide some evidence of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males (Horwood, 1987; Perry et al., 1999).

Sei whales have only been detected in the Hawaiian Islands on a few occasions. Sei whales were not sighted during aerial surveys conducted within 25 NM of the main Hawaiian Islands from 1993 to 1998 (Mobley et al., 2000). The first verified sei whale sighting made nearshore of the main Hawaiian Islands occurred in 2007 (Smultea et al., 2007; Smultea et al., 2010) and included the first subadults seen in the main Hawaiian islands. The presence of these subadults was cited as evidence suggesting that the area north of the main Hawaiian Islands may be part of a reproductive area for north Pacific sei whales (Smultea et al., 2010). A line-transect survey conducted in February 2009 by the Cetacean Research Program surrounding the Hawaiian Islands resulted in the sighting of three Bryde's/sei whales. An additional sighting occurred in 2010 off Perret Seamount (U.S. Department of the Navy, 2011b). On March 18, 2011 off Maui, the Hawaiian Islands Entanglement Response Network found a subadult sei whale entangled in rope and fishing gear (Bradford & Lyman, 2015; National Marine Fisheries Service, 2011b). An attempt to disentangle the whale was unsuccessful although a telemetry buoy attached to the entangled gear was reported to be tracking the whale over 21 days as it moved north and over 250 NM from the Hawaiian Islands. In December 2014, a passive acoustic recording device onboard an unmanned glider located to the south of Oahu detected very short, low-frequency downsweep vocalizations identified as potential sei whale calls and occurring occasionally during a period of approximately 2 weeks (Klinck et al., 2015).

Sei whales are distributed in offshore waters in the Southern California portion of the HSTT Study Area (Carretta et al., 2017c). A total of 10 sei whale sightings were made during systematic ship surveys conducted off the U.S. West Coast in summer and fall between 1991 and 2008 (Barlow, 2010), with an additional 14 groups sighted during a 2014 survey (Barlow, 2016). Sei whales were not seen in the

Southern California portion of the HSTT Study Area (or the larger Southern California Bight) during 15 aerial surveys conducted from 2008 through 2012 (Smultea et al., 2014) or during any systematic ship surveys conducted by NMFS (Barlow, 2010, 2016).

Sei whales are likely present in the Transit Corridor portion of the Study Area, and are seen at least as far south as 20° N into the North Pacific Gyre (Horwood, 2009; Horwood, 1987).

3.7.2.2.4.3 Population Trends

NMFS has determined that an assessment of the sei whale population trend will likely require additional survey data and reanalysis of all datasets using comparable methods (Carretta et al., 2017d). There are no data on Eastern North Pacific sei whale trends in abundance (Carretta et al., 2018b).

3.7.2.2.4.4 Predator and Prey Interactions

Feeding occurs primarily around dawn, which appears to be correlated with vertical migrations of prey species (Horwood, 2009). Unlike other rorquals, the sei whale skims to obtain its food, though, like other rorqual species, it does some lunging and gulping (Horwood, 2009). In the north Pacific, sei whales feed on a diversity of prey, including copepods, krill, fish [specifically sardines and anchovies], and cephalopods [squids, cuttlefish, octopuses] (Horwood, 2009; Nemoto & Kawamura, 1977). The dominant food for sei whales off California during June through August is the northern anchovy, while in September and October they eat mainly krill (Horwood, 2009; Rice, 1977). Sei whales, like other large baleen whales, are likely subject to occasional attacks by killer whales.

3.7.2.2.4.5 Species-Specific Threats

In Hawaii in 2011, a subadult sei whale was entangled in rope and fishing gear (Bradford & Lyman, 2015). For the U.S. west coast, based a documented vessel strike mortality and one serious injury to sei whales between 2012-2016 and on the statistics for other large whales, it is likely that ship strikes also pose a threat to sei whales (Carretta et al., 2017c; Carretta et al., 2018b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.2.5 Gray Whale (*Eschrichtius robustus*; Western North Pacific stock)

3.7.2.2.5.1 Status and Management

There are two north Pacific populations of gray whales: the Western subpopulation and the Eastern subpopulation (Weller et al., 2013). Both populations (stocks) could be present in the Southern California portion of the Study Area during their northward and southward migration (Mate et al., 2015a; Sumich & Show, 2011). 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 (Carretta et al., 2017c; Carretta et al., 2018b; Cooke et al., 2015; Weller et al., 2002). This stock is critically endangered and depleted throughout its range, shows no apparent signs of recovery, and should be very rare in the Southern California portion of the HSTT Study Area given they are so few in number. The Eastern North Pacific stock (also known as the eastern north Pacific or the California-Chukchi population) has recovered from whaling exploitation and was delisted under the ESA in 1994 (Swartz et al., 2006). Discussion of the Eastern North Pacific stock of gray whales is presented in Section 3.7.2.3 (Species Not Listed under the Endangered Species Act).

3.7.2.2.5.2 Habitat and Geographic Range

Gray whales are not present in the Hawaii portion of the HSTT Study Area.

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 are generally less than 225 ft. deep (Jones & Swartz, 2009).

Some gray whales make the longest annual migration of any mammal (15,000–20,000 km roundtrip; (Jones & Swartz, 2009; Mate, 2013; Mate et al., 2015a; Weller et al., 2012; Weller et al., 2013)). The migration routes of the Western North Pacific stock of gray whales had previously been poorly known and sighting data suggested that the western gray whale population had a limited range extent between the Okhotsk Sea off the coast of Sakhalin Island and the South China Sea (Weller et al., 2002). However, subsequent long-term studies of radio-tracked whales, improved photographic identification, and genetic studies have since indicated that the coastal waters of eastern Russia, the Korean Peninsula, and Japan are part of Western North Pacific stock's western Pacific migration route while other "Sakhalin" whales have been detected along the North American coast from British Columbia, Canada and as far south as and Baja California, Mexico (Mate et al., 2015a; Muir et al., 2016; Weller et al., 2002; Weller et al., 2012; Weller et al., 2013). NMFS has previously determined that 18 western gray whales have been identified in waters far enough south to have passed through the HSTT Study Area (National Marine Fisheries Service, 2014a).

Gray whales migrate between October–July (Calambokidis et al., 2015) and are only present in the Southern California portion of the HSTT Study Area while migrating through those waters. A year-long (2013-2014) survey effort in the nearshore waters off San Diego within the HSTT Study Area encountered gray whales in January, February, and in the April–June timeframe (Graham & Saunders, 2015). For purposes of the analysis in this EIS/OEIS, it is assumed that a very small percentage of migrating gray whales could be individuals from the endangered Western North Pacific stock. The timing of the October–July gray whale migrations that pass through the Southern California portion of the HSTT Study Area can be loosely categorized into three phases (Calambokidis et al., 2015; Jones & Swartz, 2009; Mate, 2013; Mate & Urban-Ramirez, 2003; Mate et al., 2015a; Rugh et al., 2008; Rugh et al., 2005). Calambokidis et al. (2015) note these migration phases are not distinct, the timing for a phase may vary based on environmental variables, and that a migration phase typically begins with a rapid increase in migrating whales, followed by moderate numbers over a period of weeks, which then slowly taper off. A southward migration from summer feeding areas off Sakhalin Island, in the Chukchi Sea, Bering Sea, Gulf of Alaska, and the Pacific Northwest begins in the fall (Calambokidis et al., 2015; Mate, 2013; Mate et al., 2015a). This Southbound Phase includes all age classes as they migrate primarily to the nearshore waters and lagoons of Baja California, Mexico as a destination. During this southward migration from October through March, the whales generally are within 10 km of the coast (Calambokidis et al., 2015), although there are documented exceptions where migrating gray whales have bypassed the coast by crossing sections of the open ocean (Mate & Urban-Ramirez, 2003; Mate et al., 2015a). In the Southern California portion of the HSTT Study Area, migrating gray whales may transit much farther offshore from the mainland as some are routinely seen near the Channel Islands and to the west of San Clemente Island (Sumich & Show, 2011). Recordings from a hydrophone array deployed offshore of central California (near Monterey) show that gray whales are acoustically active while migrating and that this acoustic behavior and their swimming behavior during migration change on daily and seasonal time scales (Guazzo et al., 2017).

Consistent with the determinations made for the identification of the Biologically Important Area migration corridor phases, Navy assumed the northward migration to the northern feeding grounds (off

Sakhalin Island for the Western North Pacific Stock) occurs in two phases just as has been determined for the Eastern North Pacific stock (Calambokidis et al., 2015). As described for the U.S. West Coast, the Northbound Phase A consists mainly of adults and juveniles that lead the beginning of the north-bound migration from late January through July, peaking in April through July. Northbound Phase A whales generally stay within 8 km of the coast (Calambokidis et al., 2015). Newly pregnant females go first to maximize feeding time, followed by adult females and males, then juveniles (Jones & Swartz, 2009). The Northbound Phase B consists primarily of cow-calf pairs which begin their northward migration later (February to July) remaining on the reproductive grounds longer to allow calves to strengthen and rapidly increase in size before the northward migration (Jones & Swartz, 2009; Mate et al., 2010). Northbound Phase B gray whales with calves migrate closer to the coast than adults and juveniles, staying generally within 5 km of the coast (Calambokidis et al., 2015). Because some gray whales may take migration paths farther offshore, an additional potential presence migration corridor has been identified along the coast of North America out to 47 km from the coastline (Calambokidis et al., 2015).

The gray whale migration corridor and additional potential presence migration buffer were identified by Calambokidis et al. (2015) as areas that should be considered important during the months they are cumulatively in use (October through July), given the potential for human activities to impact this important seasonal migration behavior. While the identified migration areas have a southern boundary ending at the border with Mexico, Navy recognizes that gray migration routes extend beyond the currently identified areas and continue on outside of the U.S. Exclusive Economic Zone (see Aquatic Mammals (2015a); Ferguson et al. (2015); Van Parijs et al. (2015) regarding the limits to the areas identified). More details in this regard are presented in Appendix K (Geographic Mitigation Assessment).

Unlike the remainder of the U.S. West Coast where phases of migration occur within specific distances from the shore, in waters south of Point Conception in the Southern California Bight, the entire migration corridor, which includes waters to the west of the Channel Islands, is used during each migration phase (Calambokidis et al., 2015). The following bullets provide the applicable season for the gray whale migration corridor and potential presence area (as detailed in Calambokidis et al. (2015)) within the Southern California portion of the HSTT Study Area:

- Southbound – October–March
- Northbound Phase A – January–July; peaking April–July
- Northbound Phase B – March–July
- Potential presence – October–July

Based on the identified migratory seasons, gray whales should only be absent from the Southern California portion of the HSTT Study Area in the August–September timeframe (Calambokidis et al., 2015). The National Oceanic and Atmospheric Administration's website containing data records for marine mammals from the Cetacean Density and Distribution Mapping Working Group (see Ferguson et al. (2015)) shows the recorded presence of gray whales in the Southern California Bight in every month of the year except June, October and November. Based on the Cetacean Density and Distribution Mapping Working Group records and area specific surveys, Navy assumes that gray whales could be migrating through the Southern California portion of the HSTT Study Area between the months of December through September, 10 months of the year.

Gray whales are generally slow-moving animals (Jefferson et al., 2015). Migrating gray whales sometimes exhibit a unique "snorkeling" behavior, whereby they surface cautiously, exposing only the area around the blowhole, exhale quietly without a visible blow, and sink silently beneath the surface

(Jones & Swartz, 2009). Mate and Urban-Ramirez (2003) reported an average gray whale speed of approximately 5.2 km per hour (km/hr.) based on a tagged migrating animal. Subsequent satellite tag data from seven additional gray whales provided by Mate et al. (2015a) showed migration swim speeds ranged from 0.6 km/hr. to 6.6 km/hr., which remains within the average previously suggested. At this average swim speed and based on data from migrating gray whales in the SOCAL portion of the HSTT Study Area (Sumich & Show, 2011), it should take approximately 24–36 hours for a gray whale to cross through the Southern California portion of the HSTT Study Area (a distance of approximately 130–250 km). It is assumed they will do this transit across the HSTT Study Area twice a year during their annual southbound and northbound migration legs. A more detailed analysis of the gray whale migration area within the Southern California portion of the HSTT Study Area is presented in Appendix K (Geographic Mitigation Assessment).

3.7.2.2.5.3 Population Trends

The Western North Pacific gray whale was once considered extinct but now small numbers are known to exist (Carretta et al., 2017c; Cooke et al., 2015; International Union for Conservation of Nature (IUCN), 2012; International Whaling Commission, 2014; Mate et al., 2015a; Weller et al., 2013). Previous data on population growth indicated a positive growth of roughly 2.5 – 3.2 percent per year (National Marine Fisheries Service, 2014a), which is consistent with the 2 - 4 percent per year increase recently provided for the Sakhalin Island portion of the population (Carretta et al., 2018b). As noted previously, 18 western gray whales have been identified in waters far enough south to have passed through the HSTT Study Area (National Marine Fisheries Service, 2014a).

3.7.2.2.5.4 Predator and Prey Interactions

Gray whales are primarily bottom feeders. Their prey includes a wide range of invertebrates living on or near the seafloor; these occur during the summer in dense colonies on the continental shelf seafloor of arctic regions (Swartz et al., 2006). The whales filter amphipods and other crustaceans with their baleen plates. The whales carry most of the sediment with them when they surface to breathe, creating mud plumes in their wake (Jefferson et al., 2015; Jones & Swartz, 2009). Gray whales occasionally engulf fishes, herring eggs, cephalopods, and crab larvae (Jefferson et al., 2015; Jones & Swartz, 2009; Newell & Cowles, 2006). Although generally fasting during the migration and calving season, opportunistic feeding (on whatever food is available) may occur in or near the calving lagoons or in the shallow coastal waters along the migration path (Jones & Swartz, 2009). During the feeding season, an adult gray whale is known to consume approximately 1,200 kilograms (kg) of food daily (Jones & Swartz, 2009).

The gray whale is preyed on by killer whales. Many individuals exhibit attack scars indicating not all attacks are fatal, however fatalities are known. Killer whales target calves during the spring migration into colder northern waters (Jones & Swartz, 2009) and include killer whale predation of gray whales as has been documented in California waters off Monterey (The Associated Press, 2017).

3.7.2.2.5.5 Species-Specific Threats

Gray whales have historically been harvested by subsistence hunters in Alaska and Russia. The International Whaling Commission sets catch limits on the annual subsistence harvest for these areas. The subsistence harvest by the Chukotka indigenous hunters (located on the Chukchi Peninsula) took a total of 127 gray whales in 2013 (Ilyashenko & Zharikov, 2014). In 2010, a gray whale discovered dead onshore in Humboldt, California had two embedded harpoons in its flesh; one of these harpoons had 10 meters of rope attached (Carretta et al., 2016b).

Incidental catches in coastal net fisheries along the coast of Japan and Asia is a significant threat to Western North Pacific gray whales, which are also susceptible to entanglement in fishing gear and ship strikes when in U.S. waters (Carretta et al., 2018b). Based on photographic data of western gray whales on their feeding ground off Sakhalin Island (Russia), approximately 19 percent of whales in the sample had detectable anthropogenic scarring resulting from fishing gear entanglement (Bradford et al., 2009). Based on reports from 2000 to 2010, a total of 22 gray whales were entangled in fishing gear off California, 16 of which were reported within the Southern California Bight (Carretta et al., 2013b; Saez et al., 2012). From 2010–2014 off the U.S. West Coast, there were 47 observed fishing related entanglements of gray whales (Carretta et al., 2016b). Unpublished data obtained from NMFS indicated 72 gray whale stranded in California between 2010-2015; 6 of those occurred in San Diego County (National Marine Fisheries Service, 2016i). This data provided does not attribute cause to these strandings, which could have arisen from any number of natural causes (predation, starvation, etc.) or from anthropogenic causes (such as marine debris entanglement). Approximately 32 percent of the strandings between 2010–2015 occurred in 2015 during a period of eastern Pacific elevated sea surface temperatures prior to onset of an extreme El Niño. None of the six San Diego County strandings nor any of the other California gray whale strandings corresponded with any Navy activities in the Southern California portion of the HSTT Study Area.

Available data from NMFS indicate that, in waters off California between 1991 and 2010, there were 30 reported ship strikes involving gray whales (National Marine Fisheries Service, 2011c); from 2010 to 2014, there were 7 reported gray whale ship strikes (Carretta et al., 2016b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.2.6 Sperm Whale (*Physeter macrocephalus*)

3.7.2.2.6.1 Status and Management

The sperm whale has been listed as endangered since 1970 under the precursor to the ESA (National Marine Fisheries Service, 2009b), and is depleted under the MMPA throughout its range, but there is no designated critical habitat for this species in the North Pacific. Sperm whales are divided into three stocks in the Pacific; two (Hawaii and California/Oregon/Washington) occur within the Study Area (Carretta et al., 2018a). Based on genetic analyses, Mesnick et al. (2011) found that sperm whales in the California Current are demographically independent from animals in Hawaii and the eastern tropical Pacific.

3.7.2.2.6.2 Habitat and Geographic Range

The sperm whale’s range extends throughout the entire Study Area. Primarily, this species is found in the temperate and tropical waters of the Pacific (Rice, 1989). Their secondary range includes areas of higher latitudes in the northern part of the Study Area (Jefferson et al., 2015; Whitehead & Weilgart, 2000; Whitehead et al., 2008; Whitehead et al., 2009). This species appears to have a preference for deep waters (Baird, 2013a; 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).

Sperm whales occur in Hawaiian waters and are one of the more abundant large whales found in that region (Baird et al., 2003b; Barlow, 2006; Bradford et al., 2017; Mobley et al., 2000). A total of 21 sperm whale sightings were made during a summer/fall 2002 shipboard survey of waters within the U.S. Exclusive Economic Zone of the Hawaiian Islands, although only four of these sightings were around the main Hawaiian Islands (Barlow, 2006). During a follow-up survey conducted in 2010, there were 41 sperm whale sightings, mainly concentrated in the northwestern portion of the U.S. Exclusive Economic Zone of the Hawaiian Islands (Bradford et al., 2017). Based on predictive habitat-based density models derived from line-transect survey data collected between 1997 and 2012 within the central North Pacific, relatively high densities of sperm whales are predicted within the U.S. Exclusive Economic Zone of the Hawaiian Islands during the summer and fall, particularly in the northwest (Forney et al., 2015). In 2015, acoustic detections of sperm whales occurred over the abyssal plain to the south of Oahu and did not seem to be related to bathymetric features such as seamounts (Klinck et al., 2015).

Sperm whales are found year round in California waters, but their abundance is temporally variable, most likely due to variation in the availability of prey species (Barlow, 1995; Barlow & Forney, 2007; Forney & Barlow, 1993; Smultea, 2014). Based on habitat models derived from line-transect survey data collected between 1991 and 2008 off the U.S. West Coast, sperm whales show an apparent preference for deep waters (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012a; Forney et al., 2012). During quarterly ship surveys conducted off southern California between 2004 and 2008, there were a total of 20 sperm whale sightings, the majority (12) occurring in summer in waters greater than 2,000 m deep (Douglas et al., 2014). Only one sperm whale group was observed during 18 aerial surveys conducted in the Southern California Bight from 2008 through 2012 (Smultea et al., 2014). Their distribution is typically associated with waters over the continental shelf break, over the continental slope, and into deeper waters (Carretta et al., 2017c; Rice, 1989; Whitehead, 2003; Whitehead et al., 2008).

Sperm whales are somewhat migratory. General shifts occur during summer months for feeding and breeding, while in some tropical areas, sperm whales appear to be largely resident (Rice, 1989; Whitehead, 2003; Whitehead et al., 2008; Whitehead et al., 2009). Pods of females with calves remain on breeding grounds throughout the year, between 40° N and 45° N (Rice, 1989; Whitehead, 2003), while males migrate between low-latitude breeding areas and higher-latitude feeding grounds (Pierce et al., 2007). In the northern hemisphere, "bachelor" groups (males typically 15 to 21 years old and bulls [males] not taking part in reproduction) generally leave warm waters at the beginning of summer and migrate to feeding grounds that may extend as far north as the perimeter of the arctic zone. In fall and winter, most return south, although some may remain in the colder northern waters during most of the year (Pierce et al., 2007).

3.7.2.2.6.3 Population Trends

For Hawaii, NMFS has determined that an assessment of the population trend will likely require additional survey data and reanalysis of all datasets using comparable methods (Carretta et al., 2017d). Sperm whale population abundance and trends based on line-transect surveys conducted off the U.S. West Coast from 1991 to 2014 include a high level of uncertainty but indicate that sperm whale abundance has appeared stable (Carretta et al., 2017d; Moore & Barlow, 2017; Moore & Barlow, 2014).

3.7.2.2.6.4 Predator and Prey Interactions

Sperm whales are known to occur in groups for both predator defense and foraging purposes. Sperm whales feed on squid, other cephalopods, and bottom-dwelling fish and invertebrates (Davis et al., 2007; Marcoux et al., 2007; Rice, 1989). The sperm whale is the largest whale that uses sound echolocation to find prey.

False killer whales, pilot whales, and killer whales have been documented harassing and on occasion attacking sperm whales (Baird, 2009a).

3.7.2.2.6.5 Species-Specific Threats

Sperm whales are susceptible to entanglement in fishing gear and ship strikes. Bradford and Lyman (2015) recorded one observed interaction between a sperm whale and longline fishing in Hawaiian waters. Based on reports from 2010 to 2014, a total of five sperm whales were entangled in fishing gear off the U.S. Pacific West Coast (Carretta et al., 2016b). The mean annual serious injury and mortality for fisheries on the U.S. West Coast, based on the 2011–2015 data, indicate a total take of 0.7 per year (Carretta et al., 2017a; Carretta et al., 2017d). Available data from NMFS indicate that in waters off the U.S. Pacific West Coast between 2011 and 2015, there was one reported ship strike involving a sperm whale in 2012 (Carretta et al., 2017d). In 2011, a neonate sperm whale stranded in Hawaii, which tested positive for both morbillivirus and brucella diseases (Jacob et al., 2016; West et al., 2015). A mass stranding in Italy in 2014 involved seven sperm whales that were all infected by morbillivirus (Mazzariol et al., 2017). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.2.7 False Killer Whale (*Pseudorca crassidens*; Main Hawaiian Islands Insular stock)

3.7.2.2.7.1 Status and Management

NMFS currently recognizes three stocks of false killer whale in Hawaiian waters: the Hawaii pelagic stock, the Northwestern Hawaiian Islands stock, and the main Hawaiian Islands insular stock (Bradford et al., 2012; Bradford et al., 2015; Bradford et al., 2018; Carretta et al., 2015; Forney et al., 2010; National Oceanic and Atmospheric Administration, 2012; Oleson et al., 2010). The main Hawaiian Islands (MHI) insular stock (considered resident to the main Hawaiian Islands consisting of Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii) is listed as an endangered Distinct Population Segment under the ESA and depleted under the MMPA throughout its range (Carretta et al., 2017c; Carretta et al., 2018a). The other two stocks of false killer whales in Hawaii, which are not listed under the Endangered Species Act, are discussed in subsequent Section 3.7.2.3 (Species Not Listed under the Endangered Species Act).

Because of this species' historic decline in numbers, NMFS published the Final Rule listing the Distinct Population Segment as endangered on 28 November 2012, effective as of 28 December 2012 (National Marine Fisheries Service, 2012b). A recovery plan for the population of MHI insular false killer whales is still under development (National Oceanic and Atmospheric Administration, 2017b).

NMFS has designated critical habitat for the MHI insular false killer whale distinct population segment by designating waters from the 45 m depth contour to the 3,200 m depth contour around the main Hawaiian Islands from Niihau east to Hawaii effective as of August 23, 2018 (83 FR 35062; Tuesday, July 24, 2018). Within these boundaries of the critical habitat, NMFS excluded certain areas from designation as shown on Figure 3.7-2.

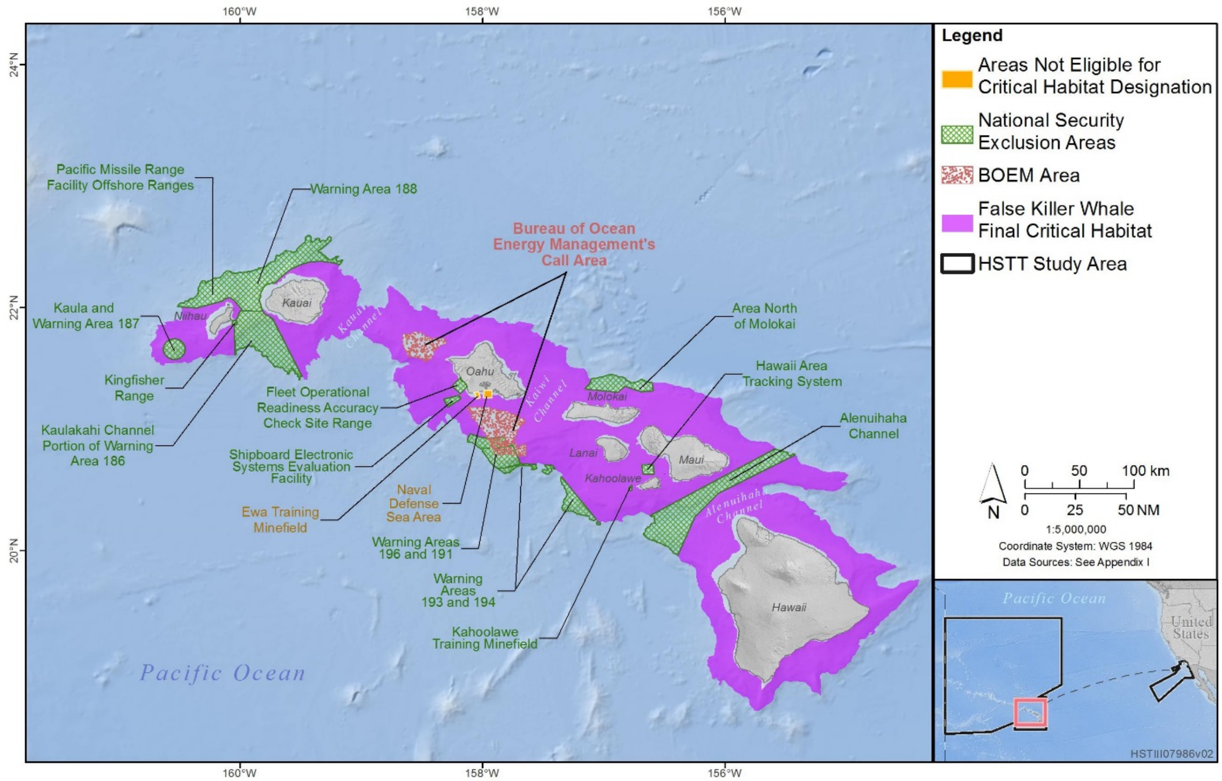


Figure 3.7-2: Main Hawaiian Islands Insular False Killer Whale Critical Habitat

The single essential feature of the MHI Insular false killer whale critical habitat has been identified as island-associated marine habitat with four characteristics that support this feature. The four characteristics include (1) adequate space for movement and use within shelf and slope habitat;(2) prey species of sufficient quantity, quality, and availability, (3) the habitat waters being free of pollutants, and (4) sound levels that will not significantly impair false killer whales' use or occupancy (83 FR 35062). Regarding sound levels applicable to this fourth characteristic, NMFS defined those as sound levels that inhibit MHI Insular false killer whale's, "…ability to receive and interpret sound for the purposes of navigation, communication, and detection of predators and prey. Such noises are likely to be long-lasting, continuous, and/or persistent in the marine environment and, either alone or added to other ambient noises, significantly raise local sound levels over a significant portion of an area." (83 FR 35062)

3.7.2.2.7.2 Habitat and Geographic Range

The false killer whale is regularly found within Hawaiian waters and has been reported in groups of up to 100 over a wide range of depths and distance from shore (Baird et al., 2003b; Baird et al., 2013a; Bradford et al., 2012; Bradford et al., 2015; Bradford et al., 2017; Oleson et al., 2013; Shallenberger, 1981).

The ranges and stock boundary descriptions for false killer whales in the Hawaiian Islands are complex and overlapping (Bradford et al., 2015; Bradford et al., 2017). For example, although there is relatively low use by insular false killer whales, all three stocks are known to overlap in the vicinity of Kauai and Niihau, which is where the Navy's underwater instrumented range offshore of Pacific Missile Range Facility has been operating since the 1980s. Passive acoustic monitoring on the Puuloa Range adjacent to the Pearl Harbor entrance documented a very low number of odontocete whistles, consistent with expectations given the relatively shallow coastal shelf bathymetry and preferred odontocete foraging behavior (Shannon et al., 2016).

IA summary of the data used to delineate the stock boundaries and the research supporting that data has been presented in the Pacific Stock Assessment Report for the MHI insular stock of false killer whales (Bradford et al., 2015; Carretta et al., 2015; Carretta et al., 2018a). Individuals from this stock have been satellite tracked as far as 115 km from the main Hawaiian Islands (Baird et al., 2015c). The MHI insular stock boundary is a 72-km radius extending around the main Hawaiian Islands, with the offshore extent of the radii connected on the leeward sides of Hawaii Island and Niihau to encompass the offshore movements of MHI insular stock animals within that region. The waters outside of 11 km from shore from Oahu to Hawaii Island and out to the MHI insular stock boundary are an overlap zone between the MHI insular stock and Hawaii pelagic stock. In the waters around Kauai and Niihau there is also overlap between the MHI insular stock and the Northwestern Hawaiian Islands stock.

A year-round Small and Resident Population area for the MHI insular stock of false killer whales has been identified (Baird et al., 2015a). Satellite tag locations from 22 individuals were mapped to grid cells. Those grid cells having a density greater than one standard deviation of the mean were considered “high-use areas” and a boundary drawn around them then constituted the identified Small and Resident Population area for the stock. A more detailed analysis of the area has been presented in Appendix K. More recent unpublished data was used by NMFS to identify high and low use areas for insular false killer whales, which was used in the designation of critical habitat (83 FR 35062) 4(b)(2) report).

False killer whales are not expected to be present in the Southern California portion of the HSTT Study Area and the species is not managed by NMFS in California waters (Carretta et al., 2017c). A nearshore marine mammal survey off San Diego in March 2014 detected a false killer whale pod (Graham & Saunders, 2015). This species normally prefers warmer tropical waters found outside of Southern California and the presence of this species to the north of its usual habitat was likely due to the warmer than normal water temperatures associated with a known El Niño event.

3.7.2.2.7.3 Population Trends

NMFS has evaluated all plausible modeled estimates of the population trend of the MHI Insular stock and found the population has declined since 1989 (Carretta et al., 2017d; Carretta et al., 2018a).

3.7.2.2.7.4 Predator and Prey Interactions

False killer whales feed primarily on deep-sea cephalopods and fish (Odell & McClune, 1999). They may prefer large fish species, such as mahi mahi and tunas. Consistent with that generalization, four MHI Insular false killer whales found stranded in Hawaii from 2010 through 2016 had stomach contents that included various squid, yellowfin tuna, mahi mahi, jack, marlin, and bonefish (West, 2016).

False killer whales have been observed to attack other cetaceans, including dolphins and large whales, such as humpback and sperm whales (Baird, 2009b). They are known to behave aggressively toward small cetaceans in tuna purse seine nets. Unlike other whales or dolphins, false killer whales frequently pass prey back and forth among individuals before they start to eat the fish, in what appears to be a way of affirming social bonds (Baird et al., 2010b). This species is believed to be preyed on by large sharks and killer whales (Baird, 2009b).

3.7.2.2.7.5 Species-Specific Threats

Like many marine mammals, false killer whales accumulate high levels of toxins in their blubber over the course of their long lives, but the consequence of that bioaccumulation remains unknown. Because false killer whales feed on large prey at the top of the food chain (e.g., squid, tunas) they may be impacted by competition with fisheries (Cascadia Research Collective, 2010). In Hawaiian waters, false killer whales are particularly susceptible to fishery interactions and entanglements (Baird et al., 2015c; Bradford & Forney, 2016). A historic decline in the MHI insular population has been the result of various non-Navy factors that include the small population size of this stock and incidental take by commercial fisheries (Bradford & Forney, 2016; Oleson et al., 2010; Reeves et al., 2009). From 2010 to 2014 there were 28 false killer whales observed interacting with the deep-set and shallow–set longline fisheries in the Hawaiian Exclusive Economic Zone (Bradford & Forney, 2017). Based on the number of false killer whale incidentally taken by commercial fisheries during 2014, a rough approximation of the 2014 total mortality and serious injury was 27 false killer whales (Carretta et al., 2017c). There were four strandings of MHI Insular false killer whales in the Hawaiian Islands in the five-year period between the start of 2010 and the end of 2016 (West, 2016). Two of these stranded animals had fishing gear (fishhooks, leaders, line) found within the stomach contents examined during necropsy (West, 2016). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.2.8 Guadalupe Fur Seal (A*rctocephalus townsendi*)

3.7.2.2.8.1 Status and Management

The Guadalupe fur seal is listed as threatened under the ESA and depleted under the MMPA throughout its range. Critical habitat for the Guadalupe fur seal has not been designated given that the only areas that meet the definition for critical habitat are outside of U.S. jurisdiction (National Oceanic and Atmospheric Administration, 1985). Guadalupe fur seals were hunted nearly to extinction during the 1800s. The last NMFS status review of the Guadalupe fur seals was conducted in 1984 but with the recent population growth and increase in distribution NMFS has initiated a new status review (Fahy, 2015). All individuals alive today are recent descendants from one breeding colony at Isla Guadalupe and Isla San Benito off Mexico and are considered a single stock (Carretta et al., 2017c; Pablo-Rodríguez et al., 2016).

3.7.2.2.8.2 Habitat and Geographic Range

The Guadalupe fur seal is typically found on shores with abundant large rocks, often at the base of large cliffs. They are also known to inhabit caves, which provide protection and cooler temperatures, especially during the warm breeding season (Belcher & Lee, 2002). Adult males, juveniles, and nonbreeding females may live at sea during some seasons or for part of a season (Reeves et al., 1992). Several observations suggest that this species travels alone or in small groups of fewer than five (Belcher & Lee, 2002; Seagars, 1984).

Guadalupe fur seals are not found in the Hawaii portion of the HSTT Study Area.

Before intensive hunting decreased their numbers, Guadalupe fur seals ranged from Monterey Bay, California, to the Revillagigedo Islands, Mexico (Aurioles-Gamboa et al., 2010). Guadalupe fur seals are most common at Guadalupe Island, Mexico, their primary breeding ground (Melin & DeLong, 1999). A second rookery was found in 1997 at the San Benito Islands off Baja California (Aurioles-Gamboa et al., 2010; Esperon-Rodriguez & Gallo-Reynoso, 2012; Maravilla-Chavez & Lowry, 1999) and they have been found in La Paz Bay in the Southern Gulf of California (Elorriaga-Verplancken et al., 2016a). Adult and juvenile males have been observed at San Miguel Island, California, since the mid-1960s, and in the late 1990s, a pup was born on the island. Sightings have also occurred at Santa Barbara, San Nicolas, and San Clemente Islands (Stewart, 1981). Other than their occurrence at San Miguel Island, Guadalupe fur seals were not observed at the other Channel Islands in NMFS aerial surveys between 2011 to 2015 (Lowry et al., 2017). Documentation of apparently healthy Guadalupe fur seals in offshore waters of Washington and British Columbia, the increased number of strandings in the Pacific Northwest, the increase in ocean temperature of the Northeastern Pacific, and their increasing population suggest that Guadalupe fur seals may be reinhabiting the northern extent of their previous range (Etnier, 2002; Lambourn et al., 2012). Satellite tracking data from Guadalupe fur seals tagged at Guadalupe Island demonstrating movements into the offshore waters of the Pacific Northwest also support this suggestion (Norris et al., 2015; Norris, 2017a, 2017b).

Guadalupe fur seals can be found in both deeper waters of the open ocean and coastal waters within the Southern California portion of the HSTT Study Area (Hanni et al., 1997; Jefferson et al., 2015; Norris, 2017b). The southern edge of the Southern California portion of the HSTT Study Area is within a few nautical miles of Guadalupe Island.

As of 2017, animals from Guadalupe Island affixed with data recording tags (n=39) have included adult females, juvenile/sub-adult males and females, and weaned pups/yearlings and there have been satellite tags (n=26) placed on rehabilitated pups/yearlings that had stranded in California that were released from central California (Gallo-Reynoso et al., 2008; Norris et al., 2015; Norris, 2017a, 2017b). Data from animals leaving Guadalupe Island indicate that Guadalupe fur seals primarily use habitats offshore of the continental shelf between 50–300 km from the U.S. West Coast, with approximately one quarter of the population foraging farther out and up to 700 km offshore (Norris, 2017a). Females with pups are generally restricted to rookery areas because they must return to nurse their pups (Gallo-Reynoso et al., 2008). Satellite tags have documented the movement of females without pups at least as far as 1,300 km north of Guadalupe Island (approximately Point Cabrillo in Mendocino County, California). Adult males have not been tagged but typically undertake some form of seasonal movement either after the breeding season or during the winter, when prey availability is reduced (Arnould, 2009). Satellite-tagged juvenile males appear to have more variable movement patterns than females, and although most remained within 600 km of Guadalupe Island, only one of ten satellite tagged males traveled north of Point Cabrillo, California (Norris, 2017a).

3.7.2.2.8.3 Population Trends

The most recent stock assessment reports (Carretta et al., 2017c; Carretta et al., 2017d) reflect the population of Guadalupe fur seals from a survey in 2010, which indicated a total estimated population size of approximately 20,000 animals. Although the estimated growth rate over the period between 1955–2010 was approximately 10 percent annually (Carretta et al., 2017c), the ongoing Unusual Mortality Event involving Guadalupe fur seals (National Oceanic and Atmospheric Administration, 2018b) is likely to have impacted that trend (Elorriaga-Verplancken et al., 2016a; Elorriaga-Verplancken et al., 2016b).

3.7.2.2.8.4 Predator and Prey Interactions

Guadalupe fur seals feed on a variety of cephalopods, fish, and crustaceans (Aurioles-Gamboa & Camacho-Rios, 2007). In the San Benito Islands, and possibly at Guadalupe Island, and the offshore waters of California, Guadalupe fur seals primarily feed on cephalopods (Aurioles-Gamboa & Camacho-Rios, 2007). Guadalupe fur seals predominantly forage at night to take advantage of prey migrating vertically through the water column (Arnould, 2009; Gallo-Reynoso et al., 2008; Ronald & Gots, 2003). Females have been observed feeding in the California Current south of Guadalupe Island and making an average round trip of 2,375 km (Arnould, 2009; Gallo-Reynoso et al., 2008; Ronald & Gots, 2003).

Guadalupe fur seals are known to be preyed on by sharks and killer whales (Belcher & Lee, 2002; Jefferson et al., 2015).

3.7.2.2.8.5 Species-Specific Threats

Carretta et al. (2013b) reported six deaths and nine serious injuries to Guadalupe fur seals along the U.S. West Coast from 2007 to 2011 due to human-related causes (primarily marine debris entanglement). Out of a total of 76 reported Guadalupe fur seals stranded along the central California coast between 2003 and 2015, 10 were caused by entanglement in marine debris (Barcenas De La Cruz et al., 2017).

In 2015 an Unusual Mortality Event was declared for Guadalupe fur seal (National Oceanic and Atmospheric Administration, 2018b). The 80 strandings in 2015 were approximately eight times higher than the historical average, occurred along the entire coast of California, consisted of mostly weaned pups and juveniles in the one- to two-year age range, and included animals in distress but alive as well as dead individuals. Findings from the majority of these stranded Guadalupe fur seals were that they were malnourished and had secondary bacterial and parasitic infections (National Oceanic and Atmospheric Administration, 2018b). It is likely that a shift in the prey may have resulting in these young animals being unable to obtain adequate food due to anomalously persistent warm ocean conditions (Bond et al., 2015). This Unusual Mortality Event was ongoing as of May 2018; there were approximately 60 Guadalupe fur seal strandings recorded in 2017 (National Oceanic and Atmospheric Administration, 2018b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.2.9 Hawaiian Monk Seal (*Neomonachus schauinslandi*)

3.7.2.2.9.1 Status and Management

The Hawaiian monk seal was listed as endangered under the ESA in 1976 (National Marine Fisheries Service, 1976) and is listed as depleted under the MMPA throughout its range (Carretta et al., 2018a, 2018b). The species is considered a high priority for recovery, based on the high magnitude of threats, the high recovery potential, and the potential for economic conflicts while implementing recovery actions (National Marine Fisheries Service, 2007d, 2011a, 2016j). The approximate area encompassed by the northwestern Hawaiian Islands was designated as the Papahanaumokuakea National Marine Monument in 2006, in part to protect the habitat of the Hawaiian monk seal. Hawaiian monk seals are managed as a single stock. There are six main reproductive subpopulations at French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Island, and Kure Atoll in the northwestern Hawaiian Islands. A recovery plan for the Hawaiian monk seal was completed in 1983 and is currently undergoing revision (National Marine Fisheries Service, 2007d, 2011a, 2016j). Due to the proximity of the Hawaiian monk seal to human development, commerce, recreation, and culture, the 2007 revised Recovery Plan included a recommendation to develop a management specifically addressing issues in the main Hawaiian Islands (National Marine Fisheries Service, 2007d). In response to that recommendation, a “Main Hawaiian Islands Monk Seal Management Plan” was developed (National Marine Fisheries Service, 2016j).

Critical habitat for Hawaiian monk seals, as shown on Figure 3.7-3, was designated August 21, 2015 (National Oceanic and Atmospheric Administration, 2015d). The essential features of the critical habitat were identified as (1) adjacent terrestrial and aquatic areas with characteristics preferred by monk seals for pupping and nursing, (2) marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging, and (3) significant areas used by monk seals for hauling out, resting, or molting (National Oceanic and Atmospheric Administration, 2015d).

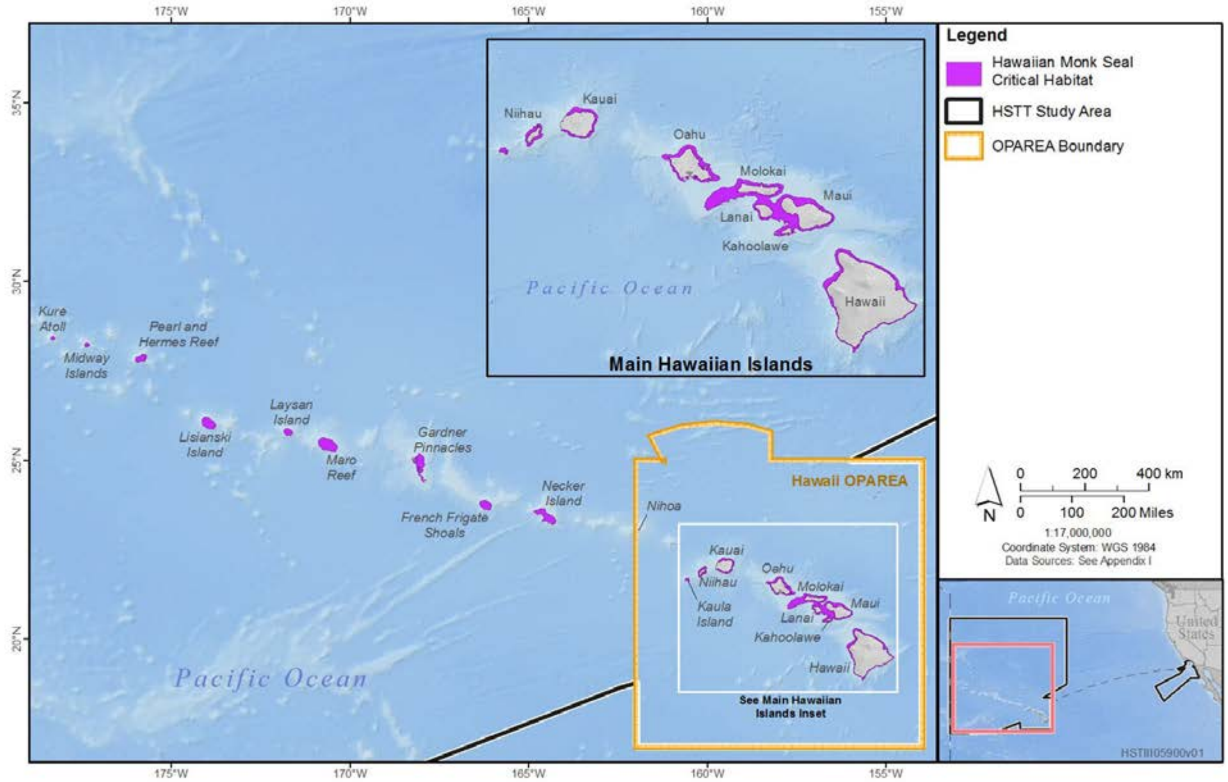


Figure 3.7-3: Hawaiian Monk Seal Critical Habitat

Section 4(a)(3) of the ESA precludes military land from a Critical Habitat designation, where that land is covered by an Integrated Natural Resource Management Plan if the Secretary of Commerce has found that plan will benefit the listed species (National Oceanic and Atmospheric Administration, 2015d). National Oceanic and Atmospheric Administration (2015c) determined that the Integrated Natural Resource Management Plans for the Pacific Missile Range Facility, Marine Corps Base Hawaii, and the Joint Base Pearl Harbor Hickam each confer conservation benefits to the Hawaiian monk seal and its habitat, and therefore the areas subject to these resource management plans were excluded from designation as Hawaiian monk seal critical habitat. Specifically, the areas determined to be ineligible for designation as critical habitat for the Pacific Missile Range Facility are the shoreline and waters off the installation on Kauai, the coastal land area/shelf/ledge of Kaula Island, and the coastal and marine areas out to 10 m in depth around the island of Niihau that are leased for naval training and testing activities. On Oahu at Marine Corps Base Hawaii on the Mokapu Peninsula, ineligible areas are the 500-yard buffer zone in marine waters surrounding the Marine Corps Base. Ineligible areas for Joint Base Pearl Harbor Hickam are beach or nearshore areas of Oahu in a 500-yard buffer zone in marine waters surrounding Puuloa Training Facility on the Ewa coastal plain, Nimitz Beach, White Plains Beach, the Naval Defensive Sea Area, the Barbers Point Underwater Range, and the Ewa Training Minefield. These lands and areas are managed by the military and have INRMPs that were reviewed in accordance with Section 4(a)(3)(B)(i) of the ESA. As detailed in National Oceanic and Atmospheric Administration 2015c, these military areas were not designated as critical habitat because they either lack the features that are essential to monk seal conservation, or they were ineligible for designation under Section 4(a)(3) of the ESA.

The Pacific Island Regional Office of NMFS has the lead responsibility for the recovery of Hawaiian monk seals under the ESA and the MMPA. Since the early 1980s, NMFS has routinely applied flipper tags to weaned pups in the northwestern Hawaiian Islands (Antonelis et al., 2006). NMFS performed capture and release programs through the Head Start Program between 1981 and 1991, "to enhance the survival of young females and thereby increase their subsequent recruitment into the adult female population." From 1984 to 1995, under NMFS's Rehabilitation Project, undersized, weaned female pups from French Frigate Shoals and, in some cases, undersized juvenile females, were brought into captivity for 8 to 10 months on Oahu to increase their weight. They were then released into the wild at either Kure Atoll or Midway Islands, where they had a higher probability of survival (Antonelis et al., 2006). Because some males were injuring female seals, in July and August of 1994, 21 adult male Hawaiian monk seals that were known aggressors or that behaved like aggressors were relocated from Laysan Island to the main Hawaiian Islands (National Marine Fisheries Service, 2009a). NMFS relocated three female monk seals (a juvenile in 1981, a pup in 1991, and an adult in 2009) from the main Hawaiian Islands to the northwestern Hawaiian Islands (National Marine Fisheries Service, 2009a).

The State of Hawaii also has important responsibilities for monk seal conservation and recovery. It owns Kure Atoll and has jurisdiction over waters between the Northwestern Hawaiian Islands Reserve boundary and 3 NM around all emergent lands in the northwestern Hawaiian Islands (except Midway) (Marine Mammal Commission, 2003). In March 2007, the State of Hawaii put new regulations into place to restrict the use of lay nets on Oahu, Molokai, Lanai, Kauai, and Niihau and prohibited lay net use in state waters around the entire island of Maui and certain areas on Oahu (National Marine Fisheries Service, 2010e). In 2008, in hopes of raising awareness about the plight of the species, Hawaii's Lieutenant Governor signed into law legislation that established the Hawaiian monk seal as the official state mammal.

When seals are reported on beaches in the main islands, NMFS works with state and local agencies to cordon off sections of beach around the seals. NMFS also relies on volunteer groups to observe seals and educate the public about their endangered status and protection measures. On Oahu, the Hawaiian Monk Seal Response Team Oahu is a team of over 50 volunteers who routinely assist National Oceanic and Atmospheric Administration Fisheries Pacific Island Regional Office and the Pacific Island Fisheries Science Center in monk seal response issues. Monk seal response programs also exist on Kauai, Maui and the Big Island, with some reporting from Molokai and Lanai (National Marine Fisheries Service, 2010e).

3.7.2.2.9.2 Habitat and Geographic Range

Hawaiian monk seals are generally only present in the main Hawaiian Islands and Northwest Hawaiian Islands, but sightings have been reported at Johnston Atoll, Wake Island, and Palmyra Atoll (south of the Hawaiian Island chain; (Carretta et al., 2010; Gilmartin & Forcada, 2009; Harting et al., 2017; Jefferson et al., 2015; National Marine Fisheries Service, 2009a, 2010c)). The six main breeding sites are in the northwestern Hawaiian Islands: Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and French Frigate Shoals. Smaller breeding sites are on Necker Island and Nihoa Island (Harting et al., 2017), and monk seals have been observed at Gardner Pinnacles and Maro Reef. There is a small breeding population of monk seals found throughout the main Hawaiian Islands and births have been documented on most of the major islands, predominately on Kauai and Niihau (Gilmartin & Forcada, 2009; National Marine Fisheries Service, 2007d, 2010c). Based on one study, on average, 10–15 percent of the monk seals move among the northwestern Hawaiian Islands and the main Hawaiian Islands (Carretta et al., 2010). Another source suggests that approximately 35 percent of the main

Hawaiian Island seals travel between islands throughout the year (Littnan, 2011). Greater than expected movement between sites within the main Hawaiian Islands and the northwestern Hawaiian Islands (Johanos et al., 2014), has allowed for genetic conductivity between Hawaiian monk seal subpopulations (Schultz et al., 2011).

When hauled out, Hawaiian monk seals seem to prefer beaches of sand, coral rubble, and rocky terraces (Baker et al., 2006; Jefferson et al., 2015). General haulout behavior differs between monk seals in the northwestern Hawaiian Islands (Harting et al., 2017) and those found in the main Hawaiian Islands (Wilson et al., 2017). Consistent with ten previous detections of monk seals at Kaula Island, in 2012 there were three individual monk seals were observed hauled out on the rock ledge on the NW side of the island (Richie et al., 2012). Aerial surveys of Kaula Island from April 2013 through March 2016 continued to document monk seals routinely hauled out on the rocky ledges at the edge of the island, numbering between five and 11 monk seals seen on each of the six surveys (Normandeau Associates & APEM, 2013a, 2013b, 2014, 2015a, 2015b, 2016).

In the main Hawaiian Islands, monk seals are generally solitary and have no established rookeries, unlike pinnipeds in Southern California. Hawaiian monk seals do, however, routinely haul out for molting and pupping in locations including at the Navy's Pacific Missile Range Facility, Pearl Harbor, and other military lands. When foraging, monk seals spend most of their time in nearshore, shallow marine habitats, but can rapidly cover large areas in search of food and may travel hundreds of miles in a few days (D'Amico, 2013; Littnan, 2011; Stewart et al., 2006; Wilson et al., 2012).

From 1996-2002, and in an effort to better understand the range of foraging monk seals, Stewart et al. (2006) used satellite-linked radio transmitters to document the movements of 147 Hawaiian monk seals from all six northwestern Hawaiian Islands breeding colonies. Foraging patterns were complex and varied among colonies by season, age and sex, but in general monk seals were found to forage extensively within the atoll barrier reefs and on the leeward slopes of reefs and islands at all colony sites. They also ranged away from these sites along the Hawaiian Islands submarine ridge to most nearby seamounts and submerged reefs and banks (Stewart et al., 2006).

Between February 2010 and July 2011, 12 data tags on monk seals in the main Hawaiian Islands were successfully deployed, retrieved, and analyzed (D'Amico, 2013; Littnan, 2011; Stewart et al., 2006; Wilson et al., 2012). The average foraging trip was approximately 30 km in distance, almost 19 hours in duration, and most seals remained within the 600 m depth contour. Although most trips were less than 50 km, two seals made at least one long pelagic foraging trip during the deployment period (Littnan, 2011). An adult male tagged on Oahu traveled over 3,000 km on a trip which lasted 36 days and a sub-adult female tagged on Kauai traveled 300 km, on one trip that lasted almost 4 days. Subsequent tags, up to and including those deployed in 2014, have demonstrated that every tagged seal occasionally undertakes foraging trips that are longer in duration or greater in distance than what would be considered "typical" for that individual (Wilson et al., 2017). Approximately 54 percent of the seals made regular trips between two or more of the islands, while the remainder showed fidelity to one island (Littnan, 2011). Follow-on data tag research on monk seals in the main Hawaiian Islands by Wilson et al. (2017) indicated the duration and distance of foraging trips were generally shorter than those observed in studies from the Northwest Hawaiian Islands, likely due to better foraging habitat or less competition in the main Hawaiian Islands.

Hawaiian monk seals are not present in the Southern California portion of the HSTT Study Area.

3.7.2.2.9.3 Population Trends

Population dynamics at different locations in the northwestern Hawaiian Islands and the main Hawaiian Islands have varied considerably (Antonelis et al., 2006). Monk seal abundance trends appear affected by the quality of local environmental conditions (Schmelzer, 2000), and limited prey availability may be restricting the recovery of the northwestern Hawaiian Islands monk seals (Baker, 2008; Iverson et al., 2011; Lowry et al., 2011).

The best estimate of the overall population trend is that the population grew at an average rate of about 4 percent per year from 2013 to 2016 (Carretta et al., 2018b). Recent information presented at the July 2017 by Hawaiian Monk Seal Recovery Team and in the current NMFS Stock Assessment Report indicates there may be a total of approximately 1,400 monk seals in the Hawaiian Islands (Amlin, 2017; Carretta et al., 2018b). While the previous decline in numbers had been driven by the population segment in the northwestern Hawaiian Islands, the number of documented sightings and annual births in the main Hawaiian Islands has increased since the mid-1990s (Baker, 2004; Baker et al., 2016b). In the main Hawaiian Islands, the estimated population growth rate is 6.5 percent per year (Baker et al., 2011; Carretta et al., 2017c; Wilson et al., 2017). It has been proposed that if those trends continue, abundances in the northwestern Hawaiian Islands and main Hawaiian Islands will equalize by the year 2020 (Littnan, 2011).

3.7.2.2.9.4 Predator and Prey Interactions

Hawaiian monk seals feed opportunistically on at least 40 species of bottom or near-bottom fish, cephalopods, and spiny lobster (Goodman-Lowe, 1998; Parrish et al., 2000; Parrish et al., 2008). Some of the more common varieties of fish include wrasses, squirrelfish, triggerfish, parrotfish, and many varieties of eels. The inner reef waters next to the islands are critical to weaned pups learning to feed; pups move laterally along the shoreline, but do not appear to travel far from shore during the first few months after weaning (Gilmartin & Forcada, 2009). Juveniles feed on small, hidden, bottom-dwelling prey (Parrish et al., 2000). Foraging habitat near breeding atolls and seamounts is commonly restricted to waters less than 100 m in depth (Parrish et al., 2000). Feeding has been observed in reef caves, as well as on fish hiding among coral formations (Parrish et al., 2000; Parrish et al., 2008). Both northwestern Hawaiian Islands and the main Hawaiian Islands monk seals have similar diets, although the diet of main Hawaiian Islands seals is less diverse and less dependent on squid (Cahoon et al., 2013) The availability of prey may be higher in the main Hawaiian Islands due to the low monk seal population and because seals have less competition with other top predators, like large sharks, jacks, and other fish, which may enhance their foraging success (Baker & Johanos, 2004; Parrish et al., 2008; Stewart et al., 2006). Most dives were less than 200 m throughout the Hawaiian Islands but 90 percent of dives at Pearl and Hermes Atoll were less than 40 m deep (Stewart et al., 2006).

Monk seals and are known to be preyed on by both killer whales and sharks. Shark predation is one of the major sources of mortality for this species, especially in the northwestern Hawaiian Islands. Galapagos sharks are a large source of juvenile mortality in the northwestern Hawaiian Islands, with most predation occurring in the French Frigate Shoals (Antonelis et al., 2006; Gilmartin & Forcada, 2009).

3.7.2.2.9.5 Species-Specific Threats

Monk seals are particularly susceptible to fishery interactions and entanglements (National Marine Fisheries Service, 2007d, 2010a, 2011a, 2011d, 2016j). Records collected in the main Hawaiian Islands show at least 140 seal hooking and entanglement incidents from 1976 to 2014 (National Marine

Fisheries Service, 2016j). In 2013 alone, there were 14 Hawaiian monk seals observed with embedded fishing hooks and one was observed with an embedded fishing spear (Carretta et al., 2015). These monk seal incidents were all classified as non-serious injuries since NMFS defines a "serious injury" as an injury "that presents a greater than 50 percent chance of death to a marine mammal" (National Marine Fisheries Service, 2012a) and all of these monk seals survived following intervention to remove those items. In the northwestern Hawaiian Islands, derelict fishing gear has been identified as a top threat to the monk seal (Donohue & Foley, 2007), while in the main Hawaiian Islands, high risks are associated with health hazards from exposure to pollutants and infectious disease agents associated with terrestrial animals. Since 2001, there have been at least 8 Hawaiian monk seals deaths attributed to parasitic toxoplasmosis from feral cats in the main Hawaiian Islands (Barbieri et al., 2017; Hawaiian Monk Seal Research Program, 2015; Rogers, 2016). In 2015, the HMSRP began a vaccination program to protect Hawaiian monk seals from morbillivirus because of the threat it poses given that monk seals do not otherwise carry antibodies to the virus (National Oceanic and Atmospheric Administration, 2015b).

Since monk seals rely on coastal habitats for survival, monk seals may be affected by future sea level rise and loss of habitat as predicted by global climate models. Another species-specific threat includes aggressive male monk seals that have been documented to injure and sometimes kill females and pups (National Marine Fisheries Service, 2010a, 2010e). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.2.10 Sea Otter (*Enhydra lutris neris*)

3.7.2.2.10.1 Status and Management

Unlike all other marine mammals in the Study Area which are under the jurisdiction of NMFS, the southern sea otter is a species under the federal jurisdiction of the United States Department of the Interior, Fish and Wildlife Service. The southern sea otter is listed as threatened under the ESA and depleted under MMPA throughout its range. In California, the southern sea otter's coastal range extends as far south as Santa Barbara County, elsewhere also referred to as part of central California (Tinker et al., 2006; U.S. Fish and Wildlife Service, 2012c). The southern sea otter range along the mainland coast therefore ends well north of the northern boundary of the Southern California Range Complex (approximately 78 NM north of the line from Dana Point to San Nicolas Island) portion of the Study Area.

In addition to the southern sea otter inhabiting the central California coastline, there was a translocated "non-essential experimental population" of sea otters established by USFWS on San Nicolas Island. San Nicolas Island is managed by the Navy and is within the overlapping boundaries of the Study Area and the Point Mugu Sea Range. The goal of the southern sea otter translocation program was to establish a population at San Nicolas Island sufficient to repopulate other areas of the range should a catastrophic oil spill affect the mainland (California coast) population. Between August 1987 and March 1990, the USFWS released 140 sea otters at San Nicolas Island (U. S. Fish and Wildlife Service, 2003). Because the translocation program did not succeed in its goals, the program was terminated by the USFWS in 2012 (U.S. Fish and Wildlife Service, 2012a). The San Nicolas island population is now considered part of the overall threatened population.

The National Defense Authorization Act for Fiscal Year 2016 included provisions directing the Secretary of the Navy to establish Southern Sea Otter Military Readiness Areas at San Nicolas Island and San Clemente Island and to provide for certain exemptions under the ESA and MMPA for southern sea otters. Specifically, the ESA and MMPA do not apply to the incidental taking of any southern sea otter at

San Nicolas Island or San Clemente Island during Navy training and testing activities. However, the 2016 National Defense Authorization Act does require that the Navy conduct monitoring and research within the Southern Sea Otter Military Readiness Areas to determine the effects of military readiness activities on the growth or decline of the southern sea otter population and on the nearshore ecosystem. The monitoring and research was designed in consultation with USFWS and the results of that work were reported to Congress in 2017 as was required. Subsequent follow-on reports will be provided every three years thereafter and findings from these reports will continue to be reviewed by Navy and USFWS to ensure the plan continues to adequately monitor interactions between military readiness activities and the sea otter population.

3.7.2.2.10.2 Habitat and Geographic Range

Sea otters are not found in the Hawaii portion of the HSTT Study Area. Sea otters in the Southern California portion of the HSTT Study Area rarely come ashore and spend most of their life in the nearshore waters around San Nicolas where they regularly swim, feed, reproduce, and rest. Sea otters may occasionally be present in deeper waters when moving between areas or in attempts to establish new habitat (Burn & Doroff, 2005).

The majority of the southern sea otter population in Southern California ranges from approximately 78 miles (mi.) north of the Study Area at Santa Barbara to as far north as Half Moon Bay, California (Tinker et al., 2006; Tinker & Hatfield, 2016; U.S. Geological Survey, 2014), which as noted above, is outside the Southern California portion of the HSTT Study Area. The southern sea otters at San Nicolas Island are there as a result of a translocation program conducted by the USFWS under the governance of Public Law 99-625. Adult and sub-adult males throughout the range tend to move to the southern range periphery (Santa Barbara County) during the late winter and early spring (Riedman & Estes, 1990; Tinker et al., 2006); however, sea otters from the central California coastal population are considered extralimital (i.e., not expected in a given area) in the Southern California Range Complex. Sea otters have been only rarely sighted within the coastal area of the Southern California Range Complex in the 10-year period from 2006 to 2016; four individuals sighted were alive and three were discovered onshore dead (Hatfield, 2017). The first occurred in June 2006 with the discovery of a dead, severely emaciated immature male sea otter at North Island. Indications from necropsy suggested a probability that he had weaned, headed south along the coast (presumably from the Santa Barbara area), and was unable to find enough food to survive (Danil, 2006).

3.7.2.2.10.3 Population Trends

There are approximately 92 southern sea otters (plus 12 pups) currently at San Nicolas Island (Tinker & Hatfield, 2016). The most recent 3-year (2013–2016) running average total count of the San Nicolas Island population continues a strong positive growth trend of approximately 13 percent per year. The sea otters at San Nicolas have historically had a growth rate that was higher than the remainder of the southern sea otter population (Tinker et al., 2006; U.S. Geological Survey, 2014), including this most recent period when the remainder of the southern sea otter population had an average growth rate of approximately three percent per year (Tinker & Hatfield, 2016).

3.7.2.2.10.4 Predator and Prey Interactions

Sea otters forage on or near the bottom in shallow waters, often in kelp beds, and bring their prey to the surface to feed (Bodkin et al., 2004). The critical foraging range for the southern sea otter is 2–35 m in depth (Tinker et al., 2006). They may occasionally hunt visually, but are most likely tactile feeders, as evidenced by a tendency to forage at night (Shimek, 1977; Wilkin, 2003; Yeates et al., 2007). Major prey items are benthic invertebrates, such as abalones, sea urchins, and rock crabs. Sea otters also eat other types of shellfish, cephalopods, and sluggish near-bottom fishes. The diet varies with the physical and biological characteristics of the habitats in which they live (Estes et al., 2009; Riedman & Estes, 1990). During El Niño events off the California coast, sea otters may also take advantage of unusually abundant prey. Squid and red crabs are examples of prey items that are only available from time to time (Estes et al., 2009).

Sea otters exhibit individual differences not only in prey choice but also in choice and method of tool use, in areas where they forage, and in water depth (Estes et al., 2009; Riedman & Estes, 1990). Some tools, such as rocks or other hard objects, are hidden in skin flaps under the front limbs (Jefferson et al., 2015). In rocky-bottom habitats, sea otters generally forage for large-bodied prey offering the greatest caloric reward. In soft-bottom habitats, prey is smaller and more difficult to find; sea otters feed on a variety of burrowing invertebrates. Based on the observation of a sea otter engaged in feeding behaviors, Tinker et al. (2007) found that the individual spent overall approximately 51 percent of the day diving for prey, with the remainder of the day spent resting on the water surface or engaged in other activities such as grooming or surface swimming.

San Nicolas Island otters are subject to different habitat conditions and stressors than those inhabiting the central California coastline (Tinker et al., 2007). Navy management and restricted access to the area has had a beneficial effect. As has been reported, the abundance of sea otter prey at San Nicolas exceeds that at the central California coastline by as much as three orders of magnitude (Tinker et al., 2007). As a result of greater prey availability for sea otters in the translocated colony at San Nicolas Island, the average food intake rate was more than double, only half as much time was spent foraging, and they were in better body condition in comparison to southern sea otter present along the central California coastline (Tinker et al., 2007).

3.7.2.2.10.5 Species-Specific Threats

The toxoplasmosis parasite (often attributed to feral cat feces in urban area storm run-off) impacts sea otters along the U.S. West Coast (Simeone et al., 2015; Siqueira et al., 2017). On land, in some cases sea otters have been preyed upon by coyotes (Weller, 2009).

Sea otters have been known to be preyed on by eagles and generally feed at night to avoid potential predators (Riedman & Estes, 1990). They are also considered likely prey for killer whales (Hatfield et al., 1988) and a known prey of sharks (Tinker et al., 2016). Since 2003 there has been an increase in the number of sea otters found with white shark bites, which are now observed on greater than 50 percent of recovered sea otter carcasses in California (Tinker et al., 2016). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

USFWS has previously noted that Department of Defense actions have not posed a threat to the San Nicolas Island colony of southern sea otters and the average growth rate for the colony has been higher than that for sea otters inhabiting the central California coastline. Current and past Navy activities had not previously triggered any regulatory requirements pursuant to the MMPA or ESA for sea otters (National Oceanic and Atmospheric Administration, 2014; U.S. Department of the Navy, 2002; U.S. Fish and Wildlife Service, 2012b, 2012c). The Navy and USFWS will coordinate as needed under any applicable statutory requirements for sea otters at San Nicolas Island.

3.7.2.3 Species Not Listed under the Endangered Species Act

As shown in Table 3.7-1, most marine mammals are not listed under the ESA, however, all are afforded protection under the MMPA. Species not listed under the ESA are discussed in the following subsections.

3.7.2.3.1 Humpback Whale (*Megaptera novaeangliae*), Hawaii Distinct Population Segment

Humpback whales that are seasonally present in the HSTT Study Area are from three Distinct Population Segments given they represent populations that are both discrete from other conspecific populations and significant to the species of humpback whales to which they belong (National Marine Fisheries Service, 2016f). These Distinct Population Segments are based on animals identified in breeding areas in Hawaii, Mexico, and Central America (Bettridge et al., 2015; Calambokidis et al., 2017; Carretta et al., 2017c; Carretta et al., 2018a; Muto et al., 2017a; National Marine Fisheries Service, 2016f; Wade et al., 2016). Information for the Hawaii Distinct Population Segment, which is seasonally present in the Hawaii portion of the HSTT Study Area, is provided in the following subsections. Discussion of the Mexico Distinct Population Segment and the Central America Distinct Population Segment that are seasonally present in the Southern California portion of the HSTT Study Area and which are listed under the ESA, are presented in Section 3.7.2.2.1 (Humpback Whale [*Megaptera novaeangliae]*, Mexico Distinct Population Segment and the Central America Distinct Population Segment).

3.7.2.3.1.1 Status and Management

In the North Pacific Ocean and under the MMPA, the stock structure of humpback whales is defined by NMFS based on the species' fidelity to feeding grounds (Bettridge et al., 2015; Muto et al., 2017a; National Marine Fisheries Service, 2016f). For humpback whales present in Hawaii in the winter and spring, NMFS has designated those animals as being part of the Central North Pacific stock, given they migrate in the summer and early fall to feed in northern British Columbia and Alaska, the Gulf of Alaska, the Bering Sea, and Aleutian Islands (Muto et al., 2017a). There is also an overlap of the Hawaii Distinct Population Segment and the Western North Pacific Distinct Population Segment as demonstrated by 35 documented matches of whales from Hawaii found in the feeding grounds off Russia (Titova et al., 2017).

The Central North Pacific stock includes animals that winter in many locations other than Hawaii including, for example, humpback whales from Japan and Mexico (Bettridge et al., 2015; Calambokidis et al., 2008; Calambokidis et al., 2017; Wade et al., 2016). Effective as of October 11, 2016, NMFS revised the species-level listing status of the humpback whale as endangered under the ESA (81 FR 62259). NMFS divided the species into 14 newly identified Distinct Population Segments, removed the previous species-level listing, and in its place listed four of the new DPSs as endangered and one DPS as threatened (81 FR 62259). Based on the available science (Bettridge et al., 2015; Calambokidis et al., 2008; Calambokidis et al., 2010; Carretta et al., 2017c; Hill et al., 2017; Muto et al., 2017a; National Marine Fisheries Service, 2016f; National Oceanic and Atmospheric Administration, 2015e; Wade et al., 2016), NMFS has designated the population of humpback whales that breed in Hawaii in the winter as the Hawaii Distinct Population Segment (National Marine Fisheries Service, 2016f). The humpback whale Hawaii Distinct Population Segment was delisted under the ESA in 2016, given that the population in Hawaii was believed to have fully recovered and have an abundance greater than the pre-whaling estimated population (Barlow et al., 2011; Bettridge et al., 2015; Muto et al., 2017a; National Marine Fisheries Service, 2016f; Wade et al., 2016).

The Hawaiian Islands Humpback Whale National Marine Sanctuary is located within the Hawaii Range Complex portion of the HSTT Study Area The Hawaiian Islands Humpback Whale National Marine Sanctuary is also discussed in Chapter 6, Other Regulatory Considerations.

3.7.2.3.1.2 Habitat and Geographic Range

Humpback whales are distributed worldwide in all major oceans and most seas (Bettridge et al., 2015; National Marine Fisheries Service, 2016f). They typically are found during the summer in high-latitude feeding grounds including Alaska and British Colombia and migrate to low-latitude wintering areas such as Hawaii, Mexico, Central America, and Okinawa where breeding and calving occurs. Humpback migrations are complex and cover long distances (Bettridge et al., 2015; Calambokidis et al., 2008; Calambokidis et al., 2009b; Calambokidis et al., 2017; Mate et al., 1998). Satellite tagging of humpback whales off Kauai found that one adult traveled 155 NM to Oahu in 4 days, while a different individual traveled to Penguin Bank and the Kalohi Channel between Molokai and Lanai, traveling 530 NM in 10 days (Mate et al., 1998). Three additional whales returning north to summer feeding grounds traveled separate routes to the north and northeast towards the Gulf of Alaska, with the fastest averaging 93 NM per day. At this rate, the animal would take an estimated 39 days to travel the entire 2,600 NM from Hawaii to the upper Gulf of Alaska (Mate et al., 1998).

Humpback whales that breed in Hawaii generally migrate to northern British Columbia and southeast Alaska to feed (Bettridge et al., 2015; Calambokidis et al., 2008; Calambokidis et al., 2017). Animals breeding in Hawaii have also been “matched” (i.e., identified as the same individual using photo-identification methods) to humpbacks feeding in the Gulf of Alaska, the Aleutian Islands, and Bering Sea (Calambokidis et al., 2008; Calambokidis et al., 2017). In all these feeding areas, humpback whales from Hawaii must cross paths with humpback whales migrating from Mexico and Central America. In addition, based on the identification of individual whales, there is evidence that some humpback whales (most likely males) move between winter breeding areas in Hawaii and Mexico (Forestell & Urban R., 2007) and Hawaii and Japan (Salden et al., 1999).

In the Hawaii portion of their range, peak densities are from February through March, although the breeding season typically spans December through April (Baird et al., 2015a; Mobley et al., 1999; Mobley et al., 2001b; Norris et al., 1999). Acoustic recordings near the northwestern Hawaiian Islands indicate that humpback whales were present in that portion of the HSTT Study Area from early December through early June (Lammers et al., 2011). It is not yet known if this represents a previously undocumented breeding stock or if the whales occurring at the northwestern Hawaiian Islands are part of the same population that winters near the main Hawaiian Islands (Bettridge et al., 2015). Acoustic recordings over multiple years using the Pacific Missile Range Facility hydrophones have demonstrated the seasonal presence of humpback whales off Kauai from November to May (Martin et al., 2016; Martin et al., 2017).

For the Hawaii Distinct Population Segment of humpback whales present in Hawaii during the breeding season, the majority of humpback whales have been detected within the 200 m isobath constituting shallow water (Mobley et al., 2001b; Mobley, 2005; Mobley & Pacini, 2013; Mobley et al., 2015). This area may include very nearshore and inland water areas (Richie et al., 2016). Investigations in the Maui Basin over 12 consecutive breeding seasons between 1997 through 2008 found that the preferences of individual mother-calf pairs for both water depth and sea-bed terrain type varied systematically during a breeding season, with the pair moving into deeper water and rougher terrain as a calf matured (Pack et al., 2017).

The greatest densities of humpback whales (including calves) have been in the four-island region consisting of Maui, Molokai, Kahoolawe, and Lanai, as well as on Penguin Bank (Mobley et al., 2001b) and around Kauai (Mobley, 2005). A March 2007 pilot survey across the Northwest Hawaiian Islands documented the existence of extensive wintering habitat used by humpback whales in the Northwest Hawaiian Islands (Johnston et al., 2007).

In December to January 2014, a passive acoustic recording device onboard an unmanned glider moving in the deep ocean approximately 100 to 300 km south of Oahu recorded humpback whale songs during all recording periods (Klinck et al., 2015). Genetic evidence collected from vocalizing animals indicates that only male humpback whales sing (Smith et al., 2008). Some vocalizing humpbacks were detected with a signal strength sufficient for the researchers to believe they were relatively close (within 20 km) to the glider and that the detections most likely did not reflect sound propagating from humpbacks potentially hundreds of kilometers to the north in the nearshore waters next to the islands. Humpback whales migrating from breeding grounds in Hawaii to feeding grounds at higher latitudes may cross western portions of the HSTT Study Area Transit Corridor.

Six locations have been identified in the main Hawaiian Islands as constituting a single biologically important reproductive area for humpback whales (Baird et al., 2015a). Detailed discussion of this area has been presented in Appendix K (Geographic Mitigation Assessment).

3.7.2.3.1.3 Population Trends

The population of humpback whales in the Hawaiian Islands has continued to increase and is now greater than some pre-whaling abundance estimates (Barlow et al., 2011; Calambokidis et al., 2017; Wade et al., 2016). Data indicate the Central North Pacific population has been increasing at a rate of between 5.5 percent and 6.0 percent per year, approximately doubling every 10 years (Bettridge et al., 2015; Muto et al., 2017a; Wade et al., 2016).

3.7.2.3.1.4 Predator and Prey Interactions

It is believed that minimal feeding occurs in wintering grounds such as the Hawaiian Islands (Balcomb, 1987; Salden, 1989). Feeding areas for the Hawaii Distinct Population Segment humpback whales include northern British Columbia, southeast Alaska, the Gulf of Alaska, the Aleutian Islands, and the Bering Sea (Bettridge et al., 2015; Calambokidis et al., 2008; Muto et al., 2017a). When in those northern waters, humpback whales feed on a wide variety of invertebrates and small schooling fishes. The most common invertebrate prey are krill (tiny crustaceans); the most common fish prey are herring, mackerel, sand lance, sardines, anchovies, and capelin (Clapham & Mead, 1999; Ford et al., 2010; Keen et al., 2018). Feeding occurs both at the surface and in deeper waters, wherever prey is abundant. Humpback whales are the only species of baleen whale that show strong evidence of cooperation when they feed in large groups (D'Vincent et al., 1985).

This species is known to be attacked by both killer whales and false killer whales, as evidenced by tooth rake scars on their bodies and fins (Jefferson et al., 2015).

3.7.2.3.1.5 Species-Specific Threats

Entanglement in fishing gear poses a threat to individual humpback whales throughout the Pacific (Bradford & Forney, 2014; Bradford & Lyman, 2015; Carretta et al., 2016b; Helker et al., 2015; Helker et al., 2017; National Oceanic and Atmospheric Administration Marine Debris Program, 2014a; Saez et al., 2013). In Hawaii during the five-year period between 2007–2012, there were 48 humpback whales found entangled in a variety of fishing gear types including longline, monofilament (hook and line), and local crab pot (trap) gear (Bradford & Forney, 2014; Bradford & Lyman, 2015). From 2010 to 2014, there were two humpback whales observed interacting with the deep-set and shallow-set longline fisheries in the Hawaiian Exclusive Economic Zone, with one resulting in serious injury (Bradford & Forney, 2017). Humpback whales from Hawaii have been reported seriously injured and killed from entanglement in fishing gear while in their Alaskan feeding grounds (Helker et al., 2015; Muto et al., 2017a; Neilson et al., 2009). Based on the stock assessment for the Central North Pacific, an overall minimum estimate of the number of fisheries interactions that cause mortality or serious injury to humpback whales is 14 annually. (Muto et al., 2017a).

From 2007–2012 in Hawaii, there were 39 collisions between humpback whales and vessels (Bradford & Lyman, 2015), none of which involved a Navy vessel[3]. In Hawaii from 1976–2011, there was a 20-fold increase in the annual incidence of reported collisions between civilian vessels and humpback whales (Lammers et al., 2013). In Hawaii, the majority of whale-vessel collisions occur off Maui in the Hawaiian Islands Humpback Whale National Marine Sanctuary where, from 2013 to 2015, there were a reported 14 vessel collisions with humpback whales (Currie et al., 2017a).

There has not been a Navy collision with a humpback whale in the last decade. For added awareness, the Navy sends out an annual message to the units training and testing in the Hawaii area providing notification when the arrival of the first humpback whales of the year have been sighted. Navy standard practice is for vessels to avoid approaching marine mammals head on and to maneuver to maintain a mitigation zone of 500 yd. around observed whales and 200 yd. around all other marine mammals (except bow-riding dolphins), providing it is safe to do so. When humpback whales from Hawaii are in Alaska, the mean vessel collision mortality and serious injury rate is 4.3 humpback whales annually (Muto et al., 2017a).

Humpback whales are potentially affected by loss of habitat, loss of prey (for a variety of reasons including climate variability), underwater noise, jet skis and similar fast waterborne tourist-related traffic, and pollutants (Muto et al., 2017a). The Central North Pacific stock of humpback whales is the focus of whale-watching activities in both its feeding grounds (Alaska) and breeding grounds (Hawaii). Regulations addressing minimum approach distances and vessel operating procedures are in place to help protect the whales from these kinds of chronic disturbance (Muto et al., 2017a). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.2 Bryde's Whale (*Balaenoptera brydei/edeni*)

3.7.2.3.2.1 Status and Management

This species is not listed under the ESA. Bryde's whales in Hawaii have been designated by NMFS as the Hawaiian stock and those in the Southern California portion of the HSTT Study Area are assigned to the Eastern Tropical Pacific stock (Carretta et al., 2017c; Carretta et al., 2018a).

3.7.2.3.2.2 Habitat and Geographic Range

[3] Bradford and Lyman (2015) report that a humpback whale was struck by a "military vessel" on February 27, 2008. On that date in Hawaii, there was a government-owned contractor-operated 40' work boat that struck something as it was returning to Pearl Harbor. Although they reported seeing a "fin," there was no whale seen, no blow, no blood in the water, and no indication whatsoever that they hit a whale. This was reported by the Navy as a potential whale strike out of an abundance of caution in case at some later date an injured marine mammal was observed with injuries consistent with a blunt force injury. Absent any indication of a whale actually being present, it should also be noted that large hammerhead sharks are common in Pearl Harbor and the possibility that a shark was struck cannot be dismissed.

Bryde's whales occur primarily in offshore oceanic waters of the north Pacific (Barlow et al., 2006; Bradford et al., 2017; Constantine et al., 2018). 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). Long migrations are not typical of Bryde's whales, although limited shifts in distribution toward and away from the equator, in winter and summer, have been observed (Best, 1996; Cummings, 1985). They are distributed throughout the North Pacific Gyre and North Pacific Transition Zone, in the Hawaiian portion of the Study Area. 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° 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 were previously only occasionally sighted in Hawaiian waters (Carretta et al., 2010; Smultea et al., 2008). The first verified Bryde's whale sighting made nearshore of the main Hawaiian Islands occurred in 2007 (Smultea et al., 2008; Smultea et al., 2010). A line-transect survey conducted in February 2009 by the Cetacean Research Program surrounding the Hawaiian Islands resulted in the sighting of three Bryde's/sei whales (Olsen et al., 2009). A summer/fall 2002 shipboard survey of waters within the U.S. Exclusive Economic Zone of the Hawaiian Islands resulted in 13 Bryde's whale sightings throughout the Study Area (Barlow et al., 2006). A total of 32 Bryde's whale sightings were made on a follow-up survey in 2010 (Bradford et al., 2017). Sightings had been more frequent in the northwest Hawaiian Islands than in the main Hawaiian Islands (Barlow et al., 2006; Smultea et al., 2008; Smultea et al., 2010). Based on predictive habitat-based density models derived from line-transect survey data collected between 1997 and 2012 within the central North Pacific, relatively high densities of Bryde's whales are predicted within the U.S. Exclusive Economic Zone of the Hawaiian Islands during the summer and fall, particularly in the northwest (Forney et al., 2015). Acoustic monitoring data collected using the Navy's instrumented training range hydrophones off the north coast of Kauai from August through October of 2014 allowed researchers to derive 17 Bryde's whale tracks as the vocalizing animals moved within the waters of the Navy range (Helble et al., 2015). Based on the Kauai acoustic data from 2014 with Bryde's whales detected as early as September, the species may be present year-round in Hawaii (Martin et al., 2017). Because Bryde's whales have been largely observed in deep offshore waters (Barlow et al., 2006; Bradford et al., 2017; Murase et al., 2015), detection of Bryde's whales closer to shore and further east in the last decade may be indicative of an overall shift in distribution for Bryde's whales in the North Pacific (Helble et al., 2015).

Bryde's whales were previously only occasionally sighted in the waters off Southern California (Carretta et al., 2010; Smultea, 2012; Smultea et al., 2011), but sightings and acoustic monitoring indicates an increase in the area so that the presence of the species is no longer considered anomalous (Carretta et al., 2017c; Debich et al., 2015a; Kerosky et al., 2012; Smultea, 2014; Smultea et al., 2010; Smultea et al., 2012b). During aerial surveys conducted year-round between 2008 and 2013 off the Southern California coast, Bryde's whales were sighted on two occasions (Jefferson et al., 2014). These were the first sightings in this area since 1991, when a Bryde's whale was sighted within 300 NM of the California coast (Barlow, 1995). The peak in recorded Bryde's whale vocalizations has varied but generally occurs between late July and November in the Southern California portion of the HSTT Study Area (Debich et al., 2015a; Debich et al., 2015b; Kerosky et al., 2012).

3.7.2.3.2.3 Population Trends

For Hawaii, NMFS has determined that an assessment of the Bryde's whale population trend will likely require additional survey data and reanalysis of all datasets using comparable methods (Carretta et al., 2017d). Although there are no data on trends in Bryde's whale abundance along the U.S. West Coast, acoustic data suggests that the seasonal presence (summer to early winter) of Bryde's whale in the Southern California Bight has been increasing over the last decade (Kerosky et al., 2012).

3.7.2.3.2.4 Predator and Prey Interactions

Bryde's whales primarily feed on schooling fish and are lunge feeders. Prey includes anchovy, sardine, mackerel, herring, krill, and other invertebrates, such as pelagic red crab (Baker & Madon, 2007; Nemoto & Kawamura, 1977). Bryde's whales have been observed using "bubble nets" to herd prey (Kato & Perrin, 2009). Bubble nets are used in a feeding strategy where the whales dive and release bubbles of air that float up in a column and trap prey inside, where they lunge through the column to feed. Bryde's whales are known to be prey for killer whales, as evidenced by an aerial observation of 15 killer whales attacking a Bryde's whale in the Gulf of California (Weller, 2009).

3.7.2.3.2.5 Species-Specific Threats

Between 2010 and 2014, one Bryde's whale from the Eastern Tropical Pacific stock (that is the stock present in the Southern California portion of the HSTT Study Area) was seriously injured as a result of a commercial vessel strike off Washington (Carretta et al., 2016b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.3 Minke Whale (*Balaenoptera acutorostrata*)

Three subspecies of the minke whale are now recognized, however, only *Balaenoptera acutorostrata scammoni* is present in the north Pacific and the Study Area (Jefferson et al., 2015).

3.7.2.3.3.1 Status and Management

The minke whale is not listed under the ESA. Minke whales in Hawaii are designated the Hawaiian stock and those in the Southern California portion of HSTT are part of the California, Oregon, and Washington stock (Carretta et al., 2017c).

3.7.2.3.3.2 Habitat and Geographic Range

The minke whale's range is known to extend from open ocean and coastal waters to subarctic and arctic waters (Kuker et al., 2005). Minke whales previously were considered a rare species in Hawaiian waters due to limited sightings during visual and aerial surveys and acoustic monitoring and appeared to only be present around the Hawaiian Islands in the October to April timeframe (Barlow, 2006; Carretta et al., 2017c; Klinck et al., 2015; Lammers et al., 2015). The first documented sighting of a minke whale close to the main Hawaiian islands was made off the southwest Coast of Kauai in 2005 (Norris et al., 2005; Rankin et al., 2007) and there have been only two other confirmed sightings within 200 NM of the Hawaiian Islands (Bradford et al., 2013; Bradford et al., 2017).

Research involving passive acoustic detection suggests minke whales are somewhat common in Hawaii in the winter (Klinck et al., 2015; Rankin & Barlow, 2005; Rankin et al., 2007; U.S. Department of the Navy, 2011b). Acoustic recordings over multiple years using the Pacific Missile Range Facility hydrophones have demonstrated the seasonal presence of minke whales off Kauai from November to May (Martin et al., 2017); this is an area where training and testing has routinely occurred for decades. During a 2002 survey around the Hawaiian Islands, minke whales were identified as the source of the mysterious "boing" sound of the north Pacific Ocean, specifically offshore of Kauai and closer in, near the Pacific Missile Range Facility, Barking Sands region (Barlow et al., 2004; Rankin & Barlow, 2005). This information subsequently allowed for acoustic detections of minke whales, although they remain rarely observed during visual surveys (Barlow, 2006; Bradford et al., 2013; Bradford et al., 2017; Lammers et al., 2015; Rankin et al., 2007). Subsequent research using the range hydrophones to count and localize vocalizations provided an estimated average density of 3.2 whales/3,780 square kilometers (Martin et al., 2015a). This was a minimum density since it was assumed that only mature male minke whales were vocalizing and being localized, and individuals capable of calling may have been silent.

Minke whales occur year-round off California (Forney et al., 1995; Forney & Barlow, 1998), mainly in nearshore areas (Barlow & Forney, 2007; Hamilton et al., 2009; Smultea, 2014). During systematic ship surveys conducted in summer and fall off the U.S. West Coast between 1991 and 2014, there were 28 minke whale sightings (Barlow, 2016). During year-round aerial surveys conducted in the Southern California Range Complex from 2008 through 2013 minke whales were sighted 19 times (Jefferson et al., 2014).

The migration paths of the minke whale include travel between breeding and feeding grounds and have been shown to follow patterns of prey availability (Jefferson et al., 2015). Minke whales generally participate in annual migrations between low-latitude breeding grounds in the winter and high-latitude feeding grounds in the summer (Kuker et al., 2005). This may explain their seasonal acoustic presence in Hawaii. There is insufficient information to determine if the year-round low numbers of minke whales detected in Southern California suggest there may be resident animals although acoustic monitoring data indicating only occasional minke boing presence in spring and late fall (Debich et al., 2015a; Hildebrand et al., 2012) would be consistent with a general seasonal migration pattern.

3.7.2.3.3.3 Population Trends

There are no data available on population size or current population trend for minke whales in Hawaiian waters (Carretta et al., 2017d; Carretta et al., 2018a).

There are no data on population trends for minke whales in the California, Oregon, and Washington stock (Carretta et al., 2017c; Carretta et al., 2018a).

3.7.2.3.3.4 Predator and Prey Interactions

Similar to other rorquals, minke whales are lunge feeders, often plunging through patches of shoaling fish or krill (Hoelzel et al., 1989; Jefferson et al., 2008b). In the north Pacific, their major prey include small invertebrates, krill, capelin, herring, pollock, haddock, and other small shoaling fish (Jefferson et al., 2008b; Kuker et al., 2005; Lindstrom & Haug, 2001). Minke whales are prey for killer whales (Ford & Ellis, 1999; Ford et al., 2005; Weller, 2009).

3.7.2.3.3.5 Species-Specific Threats

Serious injury or mortality from interactions with fishing gear poses a threat to minke whales throughout the Study Area. Between 2010 to 2014 there were three mortalities to minke whales reported (Carretta et al., 2013b; Carretta et al., 2016b). Additionally, ship strikes also potentially pose a threat to minke whales along the West Coast. Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.4 Gray Whale (*Eschrichtius robustus*; Eastern North Pacific Stock)

3.7.2.3.4.1 Status and Management

There are two north Pacific populations of gray whales: the Western subpopulation and the Eastern subpopulation. Both populations (stocks) could be present in the Southern California portion of the

Study Area during their northward and southward migration (Calambokidis et al., 2015; Carretta et al., 2017c; Carretta et al., 2018b; Cooke et al., 2015; Sumich & Show, 2011). The Western subpopulation is listed as endangered under the ESA and discussion of this stock and Distinct Population Segment is presented in Section 3.7.2.2 (Gray Whale [*Eschrichtius robustus*; Western North Pacific Stock]). The Eastern North Pacific stock (also known as the eastern north Pacific or the California-Chukchi population) appears to have recovered from exploitation and was removed from listing under the ESA in 1994 (Swartz et al., 2006).

A few hundred gray whales that feed along the Pacific coast between southeastern Alaska and northern California throughout the summer and fall are known as the Pacific Coast Feeding Group (Calambokidis et al., 2002; Carretta et al., 2017c; Mate, 2013; 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., 2017c; Weller et al., 2012; Weller et al., 2013). Photo-identification, telemetry, and genetic studies suggest that the Pacific Coast Feeding Group is demographically distinct from the Eastern North Pacific population (Calambokidis et al., 2010; Frasier et al., 2011; Mate et al., 2010). In 2012–2013, the Navy funded a satellite tracking study of Pacific Coast Feeding Group gray whales (Mate, 2013). Tags were attached to 11 gray whales near Crescent City, California in fall 2012. Good track histories were received from 9 of the 11 tags, which confirmed an exclusive near-shore (< 19 km) distribution and movement along the Northern California, Oregon, and Washington coasts (Mate, 2013). Although the duration of the tags was limited, none of the Pacific Coast Feeding Group whales moved south beyond northern California and so individuals from this group are not expected to be present in the HSTT Study Area. The Pacific Coast Feeding Group is not currently managed as a distinct stock in NMFS Stock Assessment Reports, but this may change in the future if new information supports such a designation (Carretta et al., 2015; Carretta et al., 2018b).

3.7.2.3.4.2 Habitat and Geographic Range

Gray whales are not present in the Hawaii portion of the HSTT Study Area.

Gray whales of the Eastern North Pacific stock primarily occur in shallow waters over the continental shelf of North America and Mexico and are considered to be one of the most coastal of the great whales (Jefferson et al., 2015; Jones & Swartz, 2009). Feeding grounds are generally less than 225 ft. deep (Jones & Swartz, 2009) and the main feeding areas are located in the Chukchi Sea, Bering Sea, Gulf of Alaska, the Pacific Northwest and Northern California. The main breeding grounds consist of subtropical lagoons in Baja California, Mexico (Alter et al., 2009; Jones & Swartz, 2009; Urban-Ramirez et al., 2003).

Some gray whales make the longest annual migration of any mammal(15,000–20,000 km roundtrip; (Jefferson et al., 2015; Jones & Swartz, 2009; Mate et al., 2010; Mate, 2013; Mate & Urban-Ramirez, 2003; Mate et al., 2015a; Muir et al., 2015; Weller et al., 2002; Weller et al., 2012; Weller et al., 2013)). Gray whales migrate along the Pacific coast twice a year between October and July (Calambokidis et al., 2015) and are only present in the Southern California portion of the HSTT Study Area while migrating through those waters. Although they generally remain mostly over the shelf during migration, some gray whales may be found in more offshore waters to the west of San Clemente Island and the Channel Islands further to the North (Calambokidis et al., 2015; Smultea, 2014; Sumich & Show, 2011). A year-long (2013–2014) survey effort in the nearshore waters off San Diego within the HSTT Study Area encountered gray whales in January, February, and in the April–June timeframe (Graham & Saunders, 2015). In December and April each year, gray whales are the third most encountered large cetacean in Southern California (Smultea, 2014).

The timing of the October–July gray whale migrations that pass through the Southern California portion of the HSTT Study Area can be loosely categorized into three phases (Calambokidis et al., 2015; Rugh et al., 2008). Calambokidis et al. (2015) note these migration phases are not distinct, the timing for a phase may vary based on environmental variables, and that a migration phase typically begins with a rapid increase in migrating whales, followed by moderate numbers over a period of weeks, and then slowly tapering off. A southward migration from summer feeding areas in the Chukchi Sea, Bering Sea, Gulf of Alaska, and the Pacific Northwest begins in the fall (Calambokidis et al., 2015; Mate, 2013; Mate et al., 2015a). This Southbound Phase includes all age classes as they migrate primarily to the nearshore waters and lagoons of Baja, Mexico as a destination. During this southward migration from October through March, the whales generally are within 10 km of the coast (Calambokidis et al., 2015) although there are documented exceptions where migrating gray whales have bypassed the coast by crossing sections of the open ocean (Mate, 2013; Mate & Urban-Ramirez, 2003; Mate et al., 2015a; Rice & Wolman, 1971).

In the Southern California portion of the HSTT Study Area, migrating gray whales may transit much farther offshore from the mainland as some are routinely seen near the Channel Islands and to the west of San Clemente Island (Aquatic Mammals, 2015a; Ferguson et al., 2015; Sumich, 1984; Van Parijs et al., 2015). The northward migration for the Eastern North Pacific stock to the feeding grounds in Arctic waters, Alaska, the Pacific Northwest, and Northern California occurs in two phases (Calambokidis et al., 2015). Northbound Phase A consists mainly of adults and juveniles that lead the beginning of the north-bound migration from late January through July, peaking in April through July. Newly pregnant females go first to maximize feeding time, followed by adult females and males, then juveniles (Jones & Swartz, 2009). The Northbound Phase B consists primarily of cow-calf pairs which begin their northward migration later (March to July) remaining on the reproductive grounds longer to allow calves to strengthen and rapidly increase in size before the northward migration (Jones & Swartz, 2009; Urban-Ramirez et al., 2003).

The gray whale migration corridor and the potential presence buffer and the months they are cumulatively in use (October through July) were identified by Calambokidis et al. (2015) as areas that should be considered for mitigation given the potential to impact this important seasonal migration behavior. It is important to note there are additional gray migration routes beyond the currently identified areas and outside of the U.S. Exclusive Economic Zone that may be equally as important (such the migration corridor segments in Canadian and Mexican waters; see Aquatic Mammals (2015a); Ferguson et al. (2015); Van Parijs et al. (2015) regarding the limits to the areas identified).

Unlike the remainder of the U.S. West Coast areas where phases of migration occur within specific distances from the shore, in waters south of Point Conception the entire migration corridor is used during each migration phase (Calambokidis et al., 2015). The following bullets summarize the applicable seasons for the gray whale migration (as detailed in Calambokidis et al. (2015)) along the U.S. West Coast including the Southern California portion of the HSTT Study Area:

- Southbound – October–March
- Northbound Phase A – January–July; peaking April–July
- Northbound Phase B – March–July
- Potential presence – October–July

Based on the identified migratory seasons presented by Calambokidis et al. (2015), gray whales should only be absent from the Southern California portion of the HSTT Study Area in the August–September timeframe. The National Oceanic and Atmospheric Administration's website containing data records for marine mammals from the Cetacean Density and Distribution Mapping Working Group (see Ferguson et al. (2015)) shows the recorded presence of gray whales in the Southern California Bight in every month of the year except June, October and November. As a result of the Cetacean Density and Distribution Mapping Working Group records and area specific surveys, Navy assumes that gray whales could be migrating through the Southern California portion of the HSTT Study Area between the months of December through September; 10 months of the year.

Recordings from a hydrophone array deployed offshore of central California (near Monterey), show that gray whales are acoustically active while migrating and that this acoustic behavior and their swimming behavior during migration changes on daily and seasonal time scales (Guazzo et al., 2017). Mate and Urban-Ramirez (2003) reported an average gray whale speed of approximately 5.2 km/hr. based on a tagged migrating animal. Subsequent satellite tag data from seven additional gray whales provided by Mate et al. (2015a) showed migration swim speeds ranged from 0.6 km/hr. to 6.6 km/hr.; which remains within the average previously suggested. At this average swim speed, and based on data in Sumich and Show (2011) for migrating gray whales in the SOCAL portion of the HSTT Study Area, it should take approximately 24–36 hours for a gray whale to cross through the Southern California portion of the Study Area (approximately 130–250 km). It is assumed they will do this twice a year during their annual southbound and northbound migration legs. A more detailed analysis of the gray whale migration area has been presented in Appendix K.

Most of the Eastern North Pacific stock summers in the shallow waters of the northern Bering Sea, Chukchi Sea, and western Beaufort Sea (Mate et al., 2010; Weller et al., 2013), except for approximately 200 individuals collectively known as the "Pacific Coast Feeding Group" (Calambokidis et al., 2002; Mate, 2013; Weller et al., 2013). Eastern North Pacific Gray Whales return to locations off Mexico in the fall to winter in sheltered warmer waters (Mate et al., 2010; Weller et al., 2013).

3.7.2.3.4.3 Population Trends

The eastern population has increased over several decades despite the 1999 and 2000 unusual mortality events in which an unusually large number of gray whales stranded along the coast, from Mexico to Alaska (Gulland et al., 2005), when many scientists thought the population had reached "carrying capacity" (Carretta et al., 2017c; Carretta et al., 2018b; Durban et al., 2016).

3.7.2.3.4.4 Predator and Prey Interactions

Gray whales are primarily bottom feeders. Their prey includes a wide range of invertebrates living on or near the seafloor; these occur during the summer in dense colonies on the continental shelf seafloor of arctic regions (Swartz et al., 2006). The whales filter amphipods and other crustaceans with their baleen plates. The whales carry most of the sediment with them when they surface to breathe, creating mud plumes in their wake (Jefferson et al., 2015; Jones & Swartz, 2009). Gray whales occasionally engulf fishes, herring eggs, cephalopods, and crab larvae (Jefferson et al., 2015; Jones & Swartz, 2009; Newell & Cowles, 2006). Although generally fasting during the migration and calving season, opportunistic feeding (on whatever food is available) may occur in or near the calving lagoons or in the shallow coastal waters along the migration path (Jones & Swartz, 2009).

3.7.2.3.4.5 Species-Specific Threats

Gray whales have historically been harvested by subsistence hunters in Alaska and Russia. The International Whaling Commission sets catch limits on the annual subsistence harvest for these areas. The subsistence harvest by the Chukotka indigenous hunters (located on the Chukchi Peninsula) took a total of 127 gray whales in 2013 (Ilyashenko & Zharikov, 2014). In 2010, a gray whale discovered dead onshore in Humboldt, California had two embedded harpoons in its flesh; one of these harpoons had 10 meters of rope attached (Carretta et al., 2014).

Gray whales are also susceptible to entanglement in fishing gear and ship strikes. Based on reports from 2000 to 2010, a total of 22 gray whales were entangled in fishing gear off California, 16 of which were reported within the Southern California Bight (Carretta et al., 2013b; Saez et al., 2013). From 2010 to 2014 off the U.S. West Coast, there were 47 observed fishing related entanglements of gray whales (Carretta et al., 2016b). Unpublished data obtained from NMFS indicated 72 gray whale stranded in California between 2010-2015; six of those occurred in San Diego County (National Marine Fisheries Service, 2016a, 2016b, 2016i). This data provided does not attribute cause to these strandings which could have arisen from any number of natural causes (predation, starvation, etc.) or from anthropogenic causes (such as marine debris entanglement). Approximately 32 percent of the strandings between 2010 to 2015 occurred in 2015 during a period of eastern Pacific elevated sea surface temperatures prior to onset of an extreme El Niño. None of the six San Diego County strandings nor any of the other California gray whale strandings corresponded with any Navy activities in the Southern California portion of the HSTT Study Area.

Available data from NMFS indicate that, in waters off California between 1991 and 2010, there were 30 reported ship strikes involving gray whales (National Marine Fisheries Service, 2011c); from 2010 to 2014, there were 7 reported gray whale ship strikes (Carretta et al., 2016b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.5 Dwarf Sperm Whale (*Kogia sima*)

There are two species of *Kogia*: the pygmy sperm whale (discussed in Section 3.7.2.3.6, Pygmy Sperm Whale [*Kogia breviceps*]) and the dwarf sperm whale, which had previously been considered to be the same species. Dwarf and pygmy sperm whales are difficult to distinguish from one another at sea, and many misidentifications have been made. Sightings of either species are often categorized as the genus *Kogia* (Jefferson et al., 2015).

3.7.2.3.5.1 Status and Management

The dwarf sperm whale is not listed under the ESA. Dwarf sperm whales within the Pacific U.S. Exclusive Economic Zone are divided into two separate stocks: (1) the Hawaiian stock, and (2) the California, Oregon, and Washington stock (Carretta et al., 2017c).

3.7.2.3.5.2 Habitat and Geographic Range

Dwarf sperm whales tend to occur over the outer continental shelf, and they may be relatively coastal in some areas with deep waters nearshore (MacLeod et al., 2004). Although the dwarf sperm whale appears to prefer more tropical waters than the pygmy sperm whale, the exact habitat preferences of the species are not well understood. Records of this species from both the western Pacific (Taiwan) and eastern Pacific (California) suggest that its range includes the waters off Southern California and Hawaii (Carretta et al., 2017c; Jefferson et al., 2008b; Wang et al., 2001; Wang & Yang, 2006).

During the 2002 NMFS survey of the Hawaiian Islands there were five dwarf sperm whale sightings and one sighting in the 2010 survey of the area (Barlow, 2006; Bradford et al., 2013; Bradford et al., 2017). During small boat surveys between 2002 and 2012 in the main Hawaiian Islands, this species was the fifth most frequently encountered species of odontocete in waters shallower than 1,000 m, with a strong peak in the sighting rate where depths were between 500 and 1,000 m (Baird, 2013a; Oleson et al., 2013). Dwarf sperm whales have been seen near Niihau, Kauai, Oahu, Lanai, and Hawaii. Photo-identification of individuals off Hawaii Island since 2003 has provided evidence of long-term site fidelity, with a third of identified individuals being seen in more than one year, and suggesting the existence of an island-resident population (Baird et al., 2015a; Oleson et al., 2013).

A year-round biologically important small and resident population area has been identified for dwarf sperm whales off the West Coast of the Island of Hawaii (Baird et al., 2015a). The delineated area forms a rough triangle around 55 sightings of dwarf sperm whales sighted in the area between 2002 to 2012 (Baird et al., 2015a). A more detailed analysis of the area has been presented in Appendix K (Geographic Mitigation Assessment).

Along the U.S. Pacific 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., 2015; Nagorsen & Stewart, 1983). There were no *Kogia* detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea et al., 2014). This may be somewhat due to their pelagic distribution, cryptic behavior (i.e., “hidden” because they are not very active at the surface and do not have a conspicuous blow), and physical similarity to the pygmy sperm whale (Jefferson et al., 2008b; McAlpine, 2009). However, the presence of dwarf sperm whales off the coast of California has been demonstrated by at least five dwarf sperm whale strandings in California between 1967 and 2000 (Carretta et al., 2010).

Although deep oceanic waters may be the primary habitat for this species, very few oceanic sightings offshore have occurred within the Study Area. The lack of sightings may be due to the difficulty of detecting and identifying these animals at sea (Jefferson et al., 2008b; Maldini et al., 2005).

3.7.2.3.5.3 Population Trends

In the Hawaiian Islands, there are no current data available for deriving a population abundance or trend (Carretta et al., 2015). Dwarf sperm whales are one of the more commonly stranded species in the Hawaiian Islands (Maldini et al., 2005), and the frequency of strandings indicates that the species is likely more common than sightings suggest (Jefferson et al., 2015). Strandings in Hawaii are relatively rare and there were four strandings of individual dwarf sperm whales in the Hawaiian Islands five-year period from 2010 through 2014 (National Marine Fisheries Service, 2015c).

There is no information available to estimate the population size of dwarf sperm whales off the U.S. West Coast. There are no known sighting records of this species despite many vessel surveys along the West Coast, and sightings of unidentified *Kogia* species are likely to be pygmy sperm whales (Carretta et al., 2015).

3.7.2.3.5.4 Predator and Prey Interactions

Dwarf sperm whales feed on cephalopods and, less often, on deep-sea fishes and shrimps (Caldwell & Caldwell, 1989; Sekiguchi et al., 1992). Dwarf sperm whales generally forage near the seafloor (McAlpine 2009). Killer whales are predators of dwarf sperm whales (Dunphy-Daly et al., 2008).

3.7.2.3.5.5 Species-Specific Threats

Fishery observer reports from 2007 through 2016 documented two interactions between Hawaii-based longline fishing activities and pygmy or dwarf sperm whales, which resulted in injury to those animals (Bradford & Forney, 2014; Bradford & Lyman, 2015; Bradford & Forney, 2017; Bradford, 2018). There were no mortalities observed in the California drift gillnet fishery for the most recent period monitored (2004–2008; (Carretta et al., 2017c)). In the period from 2010 to 2014 there were no records of human-related injury or mortality to this species on the U.S. West Coast (Carretta et al., 2016b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.6 Pygmy Sperm Whale (*Kogia breviceps*)

There are two species of *Kogia*: the pygmy sperm whale (*Kogia breviceps*) and the dwarf sperm whale (*Kogia sima*; discussed in Section 3.7.2.3.5, Dwarf Sperm Whale [*Kogia sima*]). Dwarf and pygmy sperm whales are difficult to detect and distinguish from one another at sea, and many misidentifications have been made. Sightings of either species are often categorized as the genus *Kogia* (Jefferson et al., 2015).

3.7.2.3.6.1 Status and Management

The pygmy sperm whale is not listed under the ESA. Pygmy sperm whales are divided into two discrete stocks: (1) the Hawaiian stock and (2) the California, Oregon, and Washington stock (Carretta et al., 2017c).

3.7.2.3.6.2 Habitat and Geographic Range

The pygmy sperm whale frequents more temperate habitats than the dwarf sperm whale, which is more of a tropical species.

Sightings of pygmy sperm whales are rarely reported in Hawaii (Baird, 2013a; Oleson et al., 2013). During boat surveys between 2000 and 2012 in the main Hawaiian Islands, this species was observed, but less commonly than the dwarf sperm whale (Baird, 2013a; Baird et al., 2003b; Baird, 2005; Barlow et al., 2004; Oleson et al., 2013). Pygmy sperm whales are one of the more commonly stranded species in the Hawaiian Islands, and the frequency of strandings indicates that the species is likely more common than sightings suggest (Maldini et al., 2005).

Pygmy sperm whales have only rarely been sighted along the U.S. West Coast during surveys and the limited sightings cannot be used to produce a reliable population estimate (Carretta et al., 2017c). Several studies have suggested that this species generally occurs beyond the continental shelf edge (Bloodworth & Odell, 2008; MacLeod et al., 2004) and all confirmed pygmy sperm whale sightings off the U.S. West Coast have been well offshore (Barlow, 2016; Hamilton et al., 2009). For California, a total of six pygmy sperm whale sightings have been made in offshore waters along the U.S. West Coast during systematic surveys conducted between 1991 and 2014 (Barlow, 2016; Hamilton et al., 2009). There were no *Kogia* detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea, 2014).

Movement patterns for this species are poorly understood. No specific information regarding routes, seasons, or resighting rates in specific areas is available for the HSTT Study Area.

3.7.2.3.6.3 Population Trends

There are no data available for an analysis of the population trend for pygmy sperm whales in the Pacific (Carretta et al., 2017c).

3.7.2.3.6.4 Predator and Prey Interactions

Pygmy sperm whales feed on cephalopods and, less often, on deep-sea fishes and shrimps (Beatson, 2007; Caldwell & Caldwell, 1989). A recent study in Hawaiian waters showed cephalopods were the primary prey of pygmy sperm whales, making up 78.7 percent of prey abundance and 93.4 percent contribution by mass (West et al., 2009). Stomach samples revealed an extreme diversity of cephalopod prey, with 38 species from 17 different families (West et al., 2009). Pygmy sperm whales have not been documented to be prey to any other species, though they are likely subject to occasional killer whale predation like other whale species.

3.7.2.3.6.5 Species-Specific Threats

Pygmy sperm whales are susceptible to fisheries interactions. Fishery observer reports from 2007 through 2016 documented two interactions between Hawaii-based longline fishing activities and pygmy or dwarf sperm whales, which resulted in injury to those animals (Bradford & Forney, 2014; Bradford & Lyman, 2015; Bradford & Forney, 2017; Bradford, 2018). In 1992 and 1993 there were two pygmy sperm whale mortalities observed in the California drift gillnet fishery but none were observed in the most recent period monitored (2004–2008) (Carretta et al., 2017c). In the period from 2010 to 2014 there were no records of human related injury or mortality to this species on the U.S. West Coast (Carretta et al., 2016b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.7 Killer Whale (*Orcinus orca*)

A single species of killer whale is currently recognized, but strong and increasing evidence indicates the possibility of several different species of killer whales worldwide, many of which are called "ecotypes" (Ford, 2008). The different geographic forms of killer whale are distinguished by distinct social and foraging behaviors and other ecological traits. In the north Pacific, these recognizable geographic forms are variously known as ''residents,'' ''transients," and "offshore" ecotypes (Hoelzel et al., 2007). In the HSTT Study Area, both the transient and offshore ecotypes are known to occur (Carretta et al., 2018b).

3.7.2.3.7.1 Status and Management

Five killer whale stocks are recognized within the Pacific U.S. Exclusive Economic Zones. The Hawaiian stock occurs in Hawaii and both the West Coast Transient stock and the Eastern North Pacific Offshore stock are present in the Southern California portion of the HSTT Study Area (Carretta et al., 2017c; Carretta et al., 2018a, 2018b). The three killer whale stocks present in HSTT Study Area are not listed under the ESA.

3.7.2.3.7.2 Habitat and Geographic Range

Killer whales are found in all marine habitats, from the coastal zone (including most bays and inshore channels) to deep oceanic basins, and from equatorial regions to the polar pack ice zones of both hemispheres. Although killer whales are also found in tropical waters and the open ocean, they are most numerous in coastal waters and at higher latitudes (Dahlheim & Heyning, 1999). Forney and Wade (2006) found that killer whale densities increased by 1 to 2 orders of magnitude from the tropics to the poles.

Although killer whales apparently prefer cooler waters, they have been observed in Hawaiian waters (Baird, 2013a; Barlow, 2006; Mobley et al., 2001a; Shallenberger, 1981). There have also been documented strandings for this species from the Hawaiian Islands (Maldini et al., 2005). Sightings are extremely infrequent in Hawaiian waters, and typically occur during winter, suggesting those sighted are seasonal migrants to Hawaii (Baird, 2013a; Baird et al., 2003a; Mobley et al., 2001a). During two separate systematic ship surveys of the Hawaiian Exclusive Economic Zone in summer/fall, there were two killer whale sightings in 2002 and a single sighting in 2010 (Barlow, 2006; Bradford et al., 2017). Baird (Baird et al., 2006a; 2006) documented 21 killer whale sightings within the Hawaiian Exclusive Economic Zone, primarily around the main Hawaiian Islands, during relatively nearshore small boat surveys occurring between 1994 and 2004. In the period from 2000 to 2012, there were two sightings with each pod consisting of four killer whales (Baird, 2013a). A single adult female was also sighted off

Kauai in July 2011 (Cascadia Research Collective, 2012). A pod of killer whales was observed off the southwest Coast of the island of Hawaii in May 2014 (Pacific Fishery Management Council, 2014).

All three ecotypes of killer whale are known to occur along the West Coast of North America, from the entire Alaskan coast, in British Columbia and Washington inland waterways, and along the outer coasts of Washington, Oregon, and California, but the endangered Resident ecotype's range does not extend south of Monterey California (Calambokidis & Barlow, 2004; Carretta et al., 2017c; Dahlheim et al., 2008; Ford & Ellis, 1999; Forney et al., 1995; National Marine Fisheries Service, 2016g). In the Southern California portion of the HSTT Study Area, only the transient and offshore ecotypes may be present (Carretta et al., 2017c). During seven systematic ship surveys of waters off the U.S. West Coast between 1991 and 2014, there were 37 killer whale sightings, only five of which were off southern California (Henderson et al., 2016). Based on two sightings from 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012, killer whales were ranked 12th in occurrence compared to other cetaceans (Jefferson et al., 2014; Smultea et al., 2014).

3.7.2.3.7.3 Population Trends

No data are available on current population trends for the Hawaii stock of killer whales or in the Southern California portion of the HSTT Study Area, for the West Coast Transient stock of killer whales (Carretta et al., 2017c; Carretta et al., 2017d; Carretta et al., 2018b; Muto et al., 2017a). NMFS considers the population trajectory for Eastern North Pacific Offshore killer whales to be stable (Carretta et al., 2018b).

3.7.2.3.7.4 Predator and Prey Interactions

Killer whales feed on a variety of prey, including bony fishes, elasmobranchs (a class of fish composed of sharks, skates, and rays), cephalopods, seabirds, sea turtles, and other marine mammals (Fertl et al., 1996; Ford et al., 2013; Ford et al., 2014; Jefferson et al., 2008b). Some populations are known to specialize in specific types of prey (Jefferson et al., 2008b; Krahn et al., 2004; Wade et al., 2009). The killer whale has no known natural predators; it is considered to be the top predator of the oceans (Ford, 2008).

3.7.2.3.7.5 Species-Specific Threats

For the killer whale stocks that are present in the HSTT Study Area, no species-specific threats have been identified other than fisheries bycatch. Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.8 False Killer Whale (*Pseudorca crassidens*; the Hawaii pelagic stock and the Northwestern Hawaiian Islands stock)

3.7.2.3.8.1 Status and Management

False killer whales are present in Hawaiian waters. NMFS currently recognizes three stocks of false killer whale in Hawaiian waters: the Hawaii pelagic stock, the Northwestern Hawaiian Islands stock, and the main Hawaiian Islands insular stock (Bradford et al., 2015; Bradford et al., 2018; Carretta et al., 2015; Carretta et al., 2018a; Forney et al., 2010; National Oceanic and Atmospheric Administration, 2012; Oleson et al., 2010).

The main Hawaiian Islands insular stock (considered resident to the main Hawaiian Islands) is listed as endangered under the ESA as a distinct population segment (National Oceanic and Atmospheric Administration, 2012), and was discussed in Section 3.7.2.2 (False Killer Whale [*Pseudorca crassidens*; main Hawaiian Islands insular stock]). The following subsections discuss known data relating to the

Hawaii Pelagic stock and the Northwestern Hawaiian Islands stock of false killer whales, which are not listed as threatened or endangered under the ESA.

The species is not expected to be present in the Southern California portion of the HSTT Study Area during the period of time covered by the Proposed Action. False killer whales are not included by NMFS as a managed species in California waters (Carretta et al., 2017c).

3.7.2.3.8.2 Habitat and Geographic Range

This species is known to occur in deep oceanic waters off Hawaii, and elsewhere in the Pacific false killer whales have been detected in acoustic surveys. They are commonly observed in the eastern tropical Pacific, generally south of the Study Area (Carretta et al., 2015; Miyashita et al., 1996; Oswald et al., 2003; Wade & Gerrodette, 1993; Wang et al., 2001). False killer whales are also regularly found within Hawaiian waters and have been reported in groups of up to 100 over a wide range of depths and distance from shore (Baird et al., 2003b; Baird et al., 2013a; Bradford et al., 2014; Bradford et al., 2015; Oleson et al., 2013; Shallenberger, 1981).

The ranges and stock boundary descriptions for false killer whales in the Hawaiian Islands are complex and overlapping. For example, all three stocks are known to overlap in the vicinity of Kauai and Niihau, which is where the Navy's underwater instrumented range has been operating since the 1980s. All significant information regarding the range of the three stocks (as of September 2015) was presented in Bradford et al. (2015). Carretta et al. (2015) provided a summary of the data used to delineate the stock boundaries, summarized the research supporting that data, and provided a synthesis in the Pacific Stock Assessment Report that is repeated in the next few paragraphs for the Hawaii Pelagic stock and the Northwest Hawaiian Islands stock.

Hawaii Pelagic stock animals have been tracked to within 11 km of the main Hawaiian Islands and throughout the Northwest Hawaiian Islands, so the pelagic stock's inner boundary is placed at 11 km from shore but there is no inner boundary within the Northwestern Hawaiian Islands (Bradford et al., 2015). Tagging data indicates that the pelagic stock has ranged as far approximately 1,000 NM from the Hawaiian Islands although the stock is only counted and assessed within an area bounded by the 200 NM Hawaii EEZ (Bradford et al., 2015; Carretta et al., 2017d).

False killer whales in the Northwestern Hawaiian Islands stock have been seen as far as 93 km from the Northwestern Hawaiian Islands and near shore around Kauai and Oahu (Baird et al., 2012; Bradford et al., 2015). The Northwestern Hawaiian Islands stock boundary is defined by a 93-km radius around Kauai, Niihau, and the Northwestern Hawaiian Islands. The entirety of the Northwestern Hawaiian Islands stock range, with the exception of the area within 11 km around Kauai and Niihau, is an overlap zone between Northwestern Hawaiian Islands stock and the Hawaii Pelagic stock false killer whales. The 93-km boundary radius around Kauai and Niihau for the Northwestern Hawaiian Islands stock partially overlaps the 72-km radius around those same islands for the main Hawaiian Islands insular stock. In 2015, a biologically important area for the main Hawaiian Islands stock as a small and resident population was identified (Baird et al., 2015a), but that designation does not apply to animals in either the Northwestern Hawaiian Islands stock or the Hawaii Pelagic stock of false killer whales.

As noted previously, false killer whales are not expected to be present in the Southern California portion of the HSTT Study Area. Older records document only a handful of sightings from areas such as Monterey Bay, Santa Catalina, and the Channel Islands (Baird, 2009b; Jefferson et al., 2008b; Miller & Scheffer, 1986). Sightings from vessel surveys also have occurred in warmer waters off Baja California, Mexico (Chivers et al., 2007). False killer whales were not detected during the 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea, 2014). A nearshore marine mammal survey off San Diego Bay in March 2014 detected a false killer whale pod that was assumed to be the same pod that had been seen 6 days before off Dana Point (Graham & Saunders, 2015). Two years later in April-March 2016, a whale watch vessel out of Dana Point again sighted a pod of false killer whales in the same area (Ritchie, 2016). This species normally prefers warmer tropical waters found outside of southern California and the presence of this species to the north of its usual habitat was likely due to the warmer-than-normal water temperatures associated with a known El Niño event.

3.7.2.3.8.3 Population Trends

No data are available for the derivation of population trends for either the Hawaii Pelagic stock or the Northwestern Hawaiian Islands stock of false killer whales in Hawaii (Bradford et al., 2018; Carretta et al., 2016c; Carretta et al., 2018a).

3.7.2.3.8.4 Predator and Prey Interactions

False killer whales feed primarily on deep-sea cephalopods and fish (Odell & McClune, 1999). They may also prefer large fish species, such as mahi mahi and tunas. Twenty-five false killer whales that stranded off the coast of the Strait of Magellan were examined and found to feed primarily on cephalopods and fish (Koen-Alonso et al., 1999). This is consistent with findings from four false killer whales found stranded in Hawaii from 2010 through 2016, whose stomach contents included prey items from various squid, yellowfin tuna, mahi mahi, jack, marlin, and bonefish (West, 2016).

False killer whales have been observed to attack other cetaceans including dolphins, and large whales, such as humpback and sperm whales (Baird, 2009a). They are known to behave aggressively toward small cetaceans in tuna purse seine nets. Unlike other whales or dolphins, false killer whales frequently pass prey back and forth among individuals before they start to eat the fish, in what appears to be a way of affirming social bonds (Baird et al., 2010b). This species is believed to be preyed on by large sharks and killer whales (Baird, 2009a).

3.7.2.3.8.5 Species-Specific Threats

Like many marine mammals, false killer whales accumulate high levels of toxins in their blubber over the course of their long lives, but the consequence of that bioaccumulation remains unknown. Because false killer whales they feed on large prey at the top of the food chain (e.g., squid, tunas) they may be impacted by competition with fisheries (Cascadia Research Collective, 2010). In Hawaiian waters, false killer whales are particularly susceptible to fishery interactions and entanglements (Baird et al., 2015c; West, 2016). A historic decline in the number of false killer whales in Hawaii is believed to have been the result of various non-Navy factors that include incidental take by commercial fisheries (Bradford et al., 2014; Oleson et al., 2010; Reeves et al., 2009). For example, from 2010 to 2014 there were 28 false killer whales observed interacting with the deep-set and shallow–set longline fisheries that are based in Hawaii, with 24 of those interactions resulting in a serious injury (Bradford & Forney, 2017). Given the boundaries for the stocks (Bradford et al., 2015), and the locations of the recorded false killer whale interactions (Bradford & Forney, 2017), all but two[4] of these 26 interactions involved pelagic false killer whales. Because 13 of the interactions occurred outside of the U.S. EEZ, those false killer whales are not counted in the abundance estimate or otherwise assessed as part of the Hawaii Pelagic stock by NMFS (Carretta et al., 2017d). There were four strandings of main Hawaiian Island Insular false killer whales in

[4] These remaining two serious injury interactions occurred in the area of overlapping ranges for the three false killer whales stocks and so could not be assigned to any particular stock; see Bradford and Forney (2017) Table 2.

the Hawaiian Islands in the five-year period between the start of 2010 and the end of 2016 (National Marine Fisheries Service, 2015d). Two of these stranded animals had fishing gear (fishhooks, leaders, line) found within the stomach contents examined during necropsy (West, 2016), which is further evidence of fishery interactions by the species in general. Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.9 Pygmy Killer Whale (*Feresa attenuata*)

3.7.2.3.9.1 Status and Management

The pygmy killer whale is not listed under the ESA. There is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands (Bradford et al., 2013; Carretta et al., 2010; Carretta et al., 2018a; Oleson et al., 2013).

3.7.2.3.9.2 Habitat and Geographic Range

The pygmy killer whale is generally an open-ocean deepwater species (Davis et al., 2000; McSweeney et al., 2009; Oleson et al., 2013; Würsig et al., 2000). Movement patterns for this species are poorly understood.

During a NMFS 2014 systematic ship survey off the U.S. West Coast, when there were unusually warm water conditions, a group of 27 pygmy killer whales was sighted in offshore waters of southern California (Barlow, 2016). Given that there is a remote likelihood for this species to occur regularly off the U.S. West Coast, the 2015 Pacific Stock Assessment report does not include pygmy killer whales as a managed stock in California waters (Carretta et al., 2017c).

This species' range in the open ocean generally extends to the southern regions of the North Pacific Gyre and the southern portions of the North Pacific Transition Zone. Many sightings have occurred from cetacean surveys of the eastern tropical Pacific (Au & Perryman, 1985; Barlow & Gisiner, 2006; Wade & Gerrodette, 1993). This species is also known to be present in the western Pacific (Wang & Yang, 2006). Its range is generally considered to be south of 40° N and continuous across the Pacific (Donahue & Perryman, 2009; Jefferson et al., 2008b). Groups of pygmy killer whales were sighted five times during the NMFS 2010 survey of the Hawaiian Islands (Bradford et al., 2017).

A year-round biologically important small and resident population area has been identified for pygmy killer whales off the Island of Hawaii (Baird et al., 2015a). The delineated area extends along the coast of Hawaii Island from northwest of Kawaihae to South Point and along the southeast coast of the island, as determined by locations from two satellite-tagged individuals, photo-identification data, extensive vessel-based survey data, and expert judgment (Baird et al., 2015a). A more detailed analysis of the area has been presented in Appendix K.

3.7.2.3.9.3 Population Trends

NMFS has determined that an assessment of the population trend for pygmy killer whales will likely require additional survey data for the species (Carretta et al., 2017d).

3.7.2.3.9.4 Predator and Prey Interactions

Pygmy killer whales feed predominantly on fish and squid. They have been known to attack other dolphin species, apparently as prey, although this is not common (Jefferson et al., 2008b; Perryman & Foster, 1980; Ross & Leatherwood, 1994). The pygmy killer whale has no documented predators (Weller, 2009), although it may be subject to predation by killer whales.

3.7.2.3.9.5 Species-Specific Threats

Fisheries interactions are likely, as evidenced by a pygmy killer whale that stranded on Oahu with signs of a hooking injury (National Marine Fisheries Service, 2007b), the report of mouth-line injuries noted in some individuals (Baird unpublished data cited in Carretta et al. (2017c)), and one observed mortality during longline fishing in Hawaiian waters in 2013 (Bradford & Forney, 2017). The 2017 Pacific Stock Assessment Report (Carretta et al., 2017c; Carretta et al., 2017d) suggests that two mass-strandings of pygmy killer whales (that occurred in 2004 and 2005) were, "… possibly associated with offshore naval training exercises" based on the citation to Wang and Yang (2006). That citation (Wang & Yang, 2006) only speculatively suggested that, "… naval sonar and live ammunition exercises are two of many plausible causes that need to be investigated …", given there was a lack of necessary information (such as if sonar was even in use) regarding relatively contemporaneous and distant events involving the U.S. Navy, Peoples Republic of China Navy, Taiwan Navy, and the Japanese Navy and oil and gas seismic exploration occurring in the eastern Pacific. Complicating the identification of a cause for these particular stranding events, is that in the period between 1995 and 2005 there were a total of six pygmy killer whale mass stranding events and three milling events involving the same species in Taiwan (Brownell et al., 2009b; Yang et al., 2008). The suggestion that sonar, underwater detonations, or seismic oil and gas exploration may have caused the particular 2004 and 2005 strandings has remained speculative, with researchers pointing to the need for further investigation (Brownell et al., 2009b; Wang & Yang, 2006; Yang et al., 2008). The technical report titled "Marine Mammal Strandings Associated with U.S. Navy Sonar Activities" (U.S. Department of the Navy, 2017b), provides a general discussion of strandings potentially related to the use of sonar and other anthropogenic sound. One pygmy killer whale stranded in Hawaii has tested positive for morbillivirus, although the prevalence of disease in the population is unknown (Carretta et al., 2017d; Jacob et al., 2016). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.10 Short-finned Pilot Whale (*Globicephala macrorhynchus*)

3.7.2.3.10.1 Status and Management

Short-finned pilot whales are not listed under the ESA. For MMPA stock assessment reports, short-finned pilot whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete stocks: (1) the Hawaiian stock, and (2) the California, Oregon and Washington stock (Carretta et al., 2017c; Carretta et al., 2018a).

3.7.2.3.10.2 Habitat and Geographic Range

The short-finned pilot whale is widely distributed throughout most tropical and warm temperate waters of the world and occurs in waters over the continental shelf break, in slope waters, and in areas of high topographic relief (Baird, 2013a; Olson, 2009). While pilot whales are typically distributed along the continental shelf break, movements over the continental shelf are commonly observed in the northeastern United States (Payne & Heinemann, 1993) and close to shore at oceanic islands like Hawaii, where the shelf is narrow and deeper waters are found nearby (Baird, 2013b; Gannier, 2000; Mignucci-Giannoni, 1998). Short-finned pilot whales are not considered a migratory species, although seasonal shifts in abundance have been noted in some portions of the species' range. A number of studies in different regions suggest that the distribution and seasonal inshore/offshore movements of pilot whales coincide closely with the abundance of squid, their preferred prey (Bernard & Reilly, 1999; Hui, 1985; Payne & Heinemann, 1993).

Short-finned pilot whales in the Hawaiian Islands were the most commonly encountered species of odontocete during near-shore surveys in depths over 2,000 m and were the second most common odontocete encountered during the NMFS 2002 (25 sightings) and 2010 (36 sightings) systematic ship surveys of the Hawaiian Exclusive Economic Zone (Baird, 2013a; Barlow, 2006; Bradford et al., 2013; Oleson et al., 2013). Small boat surveys from 2003 through 2007 photo-identified 250 individuals seen in more than one year, suggesting site fidelity (Abecassis et al., 2015; Mahaffy et al., 2015; Oleson et al., 2013). Habitat-based models developed from systematic ship survey data collected in the central North Pacific show some of the highest short-finned pilot whale densities around the Hawaiian Islands (Becker et al., 2012b; Forney et al., 2015). Twenty-three strandings of this species have been recorded at the main Hawaiian Islands, including five mass strandings and four strandings since 2007 (Carretta et al., 2015; Maldini et al., 2005). On October 31, 2017, at least five pilot whales live-stranded in Nawiliwili Harbor on Kauai. NMFS has yet to determine a cause for that stranding. As detailed in the Section 3.7.3.1.1.6 (Stranding) and in the Technical Report on Marine Mammal Strandings Associated with U.S. Navy Sonar Activities (U.S. Department of the Navy, 2017b), the cause(s) for the majority of strandings cannot be determined.

A year-round biologically important small and resident population area has been identified for short-finned pilot whales off the Island of Hawaii (Baird et al., 2015a). The delineated area extends along the coast of Hawaii Island as determined by a polygon drawn around the locations from 35 satellite-tagged deployments defining a high-use area (Baird et al., 2015a; Mahaffy et al., 2015). A more detailed analysis of the area has been presented in Appendix K (Geographic Mitigation Assessment).

Short-finned pilot whale distribution off Southern California changed dramatically after El Niño in 1982–1983, when squid did not spawn as usual in the area, and pilot whales virtually disappeared from the area for 9 years (Jefferson & Schulman-Janiger, 2018; Shane, 1995). There were nine short-finned pilot whale sightings during seven systematic ship surveys conducted by NMFS off California, Oregon, and Washington between 1991 and 2014, with three of these off southern California (Barlow & Forney, 2007; Barlow, 2016). There were two additional short-finned pilot whale sightings during 16 ship surveys conducted by the state of California in the Southern California Bight between 2004 and 2008 (Douglas et al., 2014). Short-finned pilot whales were not sighted during 18 aerial surveys conducted in the Southern California Bight between 2008 and 2013 (Jefferson et al., 2014). A group of approximately 50 individuals was encountered off San Diego in May 2015 and included an individual photo-identified previously off Ensenada, Mexico (Kendall-Bar et al., 2016).

3.7.2.3.10.3 Population Trends

For Hawaiian waters, NMFS has determined that an assessment of population trend will likely require additional survey data and reanalysis of all datasets using comparable methods (Carretta et al., 2017d).

Pilot whales appear to have returned to California waters as evidenced by an increase in sighting records, as well as incidental fishery bycatches (Barlow & Forney, 2007; Barlow, 2016; Douglas et al., 2014; Jefferson & Schulman-Janiger, 2019; Kendall-Bar et al., 2016). Because these changes likely reflect a change in distribution based on a changing environment rather than a change in the population, there can be no assessment of the current population trend for short-finned pilot whales in California (Carretta et al., 2017c).

3.7.2.3.10.4 Predator and Prey Interactions

Pilot whales feed primarily on squid but also take fish (Bernard & Reilly, 1999). They are generally well adapted to feeding on squid (Jefferson et al., 2008b; Werth, 2006a, 2006b). Analysis of satellite tagging data from pilot whales in Hawaii correlated with certain environmental parameters suggesting that the deep mesopelagic boundary community serves as prey for these whales (Abecassis et al., 2015).

Pilot whales are not generally known to prey on other marine mammals, but records from the eastern tropical Pacific suggest that the short-finned pilot whale does occasionally chase and attack dolphins during fishery operations and may eat them (Olson, 2009; Perryman & Foster, 1980). They have also been observed harassing sperm whales in the Gulf of Mexico (Weller et al., 1996).

This species is not known to have any predators (Weller, 2009), although it may be subject to predation by killer whales.

3.7.2.3.10.5 Species-Specific Threats

From 2008 to 2012, three short-finned pilot whales were observed interacting with the longline fishery in the Hawaiian Islands (Bradford & Forney, 2014) and one mortality to the species observed from that fishery in 2013 (Bradford & Forney, 2017). On October 31, 2017, at least five pilot whales live-stranded in Nawiliwili Harbor on Kauai. NMFS has yet to determine a cause for that stranding. As detailed in Section 3.7.3.1.1.6 (Stranding) and in the *Technical Report on Marine Mammal Strandings Associated with U.S. Navy Sonar Activities* (U.S. Navy Marine Mammal Program & SPAWAR Systems Center Pacific, 2017), the cause(s) for the majority of strandings cannot be determined. Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.11 Melon-headed Whale (*Peponocephala electra*)

3.7.2.3.11.1 Status and Management

The melon-headed whale is not listed under the ESA. There are two Pacific management stocks within the Hawaiian Islands Exclusive Economic Zone based on photo-identification, social network analysis, movement data, and genetics (Oleson et al., 2013). These stocks are 1) the Kohala Resident stock, which includes melon-headed whales off the Kohala and West Coast of Hawaii Island in less than 2,500 m of water, and 2) the Hawaiian Islands stock, which includes melon-headed whales inhabiting waters throughout the U.S. Exclusive Economic Zone of the Hawaiian Islands (Aschettino et al., 2012; Baird et al., 2015a; Carretta et al., 2017c; Carretta et al., 2018a; Oleson et al., 2013).

3.7.2.3.11.2 Habitat and Geographic Range

Melon-headed whales are found worldwide in tropical and subtropical waters but movement patterns for this species are poorly understood. They have occasionally been reported at higher latitudes, but these areas are considered to be beyond their normal range, because the records indicate these movements occurred during incursions of warm water currents (Jefferson et al., 2015; Perryman et al., 1994; Perryman, 2009). In the north Pacific, occurrence of this species is well known in deep waters off many areas, including the Hawaii portion of the Study Area (Aschettino et al., 2012; Au & Perryman, 1985; Ferguson, 2005; Perrin, 1976; Wang et al., 2001).

The melon-headed whale is regularly found within Hawaiian waters (Baird et al., 2003a; Baird et al., 2003b; Baird et al., 2010a; Baird et al., 2015b; Mobley et al., 2000; Shallenberger, 1981). Large groups are seen regularly, especially off the Waianae coast of Oahu, the north Kohala coast of Hawaii, and the leeward coast of Lanai (Baird, 2006; Oleson et al., 2013; Shallenberger, 1981). The Kohala resident stock and the Hawaiian Islands stock overlap throughout the range of the Kohala resident stock. Two ship-based, visual line-transect surveys were conducted during the summer-fall of 2002 and 2010 in the U.S. Exclusive Economic Zone of the Hawaiian Islands and encountered single groups of 89 melon-headed whales (Baird, 2006) and 153 melon-headed whales (Bradford et al., 2013), respectively. Brownell et al. (2009a) found that melon-headed whales near oceanic islands rest near shore during the day, and feed in deeper waters at night. Melon-headed whales are known to enter shallow water areas on occasion, although these are generally characterized as animals being "out of habitat" and/or "mass strandings"; a few hundred did so at Hanalei Bay, Kauai and Sasanhaya Bay, Rota (Mariana Islands) on July 4, 2004 (Jefferson et al., 2006), and similar sized groups have done so in the Philippines as well, entering Manila Bay in Feb 2009 and the bay at Odiongan, Romblon in March of 2009 (Aragones et al., 2010). In surveys around the main Hawaiian Islands, melon-headed whales showed no clear pattern in depth use (Baird, 2013a).

A year-round biologically important small and resident population area has been identified for melon-headed whales off the Island of Hawaii (Baird et al., 2015a). The delineated area forms a roughly triangular polygon centered off Kawaihae (Hawaii Island) as determined by a polygon drawn around the locations from four satellite-tagged individuals, photo-identification data, extensive vessel-based survey data, and expert judgment (Baird et al., 2015a). The data used to delineate the area is discussed in greater detail in Appendix K.

During ship-based bird surveys in the eastern tropical Pacific, this species was observed from the U.S.-Mexico border south to Peru, typically associated with pelagic sea birds while foraging (Pitman & Ballance, 1992). The species is not expected to be present in the Southern California portion of the HSTT Study Area.

3.7.2.3.11.3 Population Trends

For the Kohala Resident stock, photo identification of individuals encountered between 2002 and 2009 provided for an abundance estimate of 477 (CV = 0.27) in that island associated population (Aschettino et al., 2012; Carretta et al., 2017d). For the Hawaiian Islands stock, data from a 2010 shipboard line-transect survey has provided for an abundance estimate of 8,666 (CV = 1.00) melon-headed whales other than the Kohala Resident stock (Bradford et al., 2017; Carretta et al., 2017d). NMFS has determined that assessment of population trend for either population will likely require additional survey data for the species (Carretta et al., 2017d).

3.7.2.3.11.4 Predator and Prey Interactions

Melon-headed whales prey on squid, pelagic fishes, and occasionally crustaceans. Most of the fish and squid families eaten by this species consist of mid-water animals found in waters up to 1,500 m deep, suggesting that feeding takes place deep in the water column (Jefferson & Barros, 1997). Melon-headed whales are believed to be preyed on by killer whales and have been observed fleeing from killer whales in Hawaiian waters (Baird et al., 2006c).

3.7.2.3.11.5 Species-Specific Threats

Species-specific threats to melon-headed whales in Hawaii may include interactions with fishing activities. Bradford and Forney (2016) note that from 2009 through 2013 there were 11 observed Hawaii longline fishery interactions with cetaceans which were not identified to a species and therefore may have involved melon-headed whales. The 2015 Pacific Stock Assessment Report (Carretta et al., 2017c) suggests that underwater sound may also be source of mortality to this species; see the U.S. Navy's Technical Report "Marine Mammal Strandings Associated with U.S. Navy Sonar Activities" (U.S. Department of the Navy, 2017b) for a general discussion of strandings potentially related to the use of sonar and other anthropogenic sound. Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.12 Long-beaked Common Dolphin (*Delphinus capensis*)

Common dolphins are represented by two species for management purposes in the NMFS Pacific Stock Assessment Report (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 the NMFS naming convention.

3.7.2.3.12.1 Status and Management

This species is not listed under the ESA. For the NMFS stock assessment reports, there is a single Pacific management stock for those animals found within the U.S. Exclusive Economic Zone off the U.S. West Coast, which is called the California, Oregon, and Washington stock (Carretta et al., 2017c).

3.7.2.3.12.2 Habitat and Geographic Range

Long-beaked common dolphins are not present in the Hawaii portion of the HSTT Study Area.

The long-beaked common dolphin appears to be restricted to waters relatively close to shore (Jefferson & Van Waerebeek, 2002; Perrin, 2009a), apparently preferring shallower and warmer water than the short-beaked common dolphin (Becker et al., 2016; Perrin, 2009a). Off California and Baja California, Mexico, long-beaked common dolphins are commonly found within 50 NM of the coast (Carretta et al., 2011; Gerrodette & Eguchi, 2011). This species is found off Southern California year round, but it may be more abundant there during the warm-water months (May to October) (Barlow & Forney, 2007; Bearzi, 2005b; Douglas et al., 2014; Henderson et al., 2014a; Heyning & Perrin, 1994). Stranding data and sighting records suggest that this species' abundance fluctuates seasonally and from year to year off California (Carretta et al., 2011; Douglas et al., 2014; Henderson et al., 2014a). Southern California waters represent the northern limit to this species' range and the seasonal and inter-annual changes in abundance off California are assumed to reflect the shifts in the movements of animals between U.S. and Mexican waters (Carretta et al., 2017c).

3.7.2.3.12.3 Population Trends

There appears to be an increasing trend in the abundance of long-beaked common dolphin in southern California waters over the last 30 years (Carretta et al., 2017c; Jefferson et al., 2014).

3.7.2.3.12.4 Predator and Prey Interactions

The genus *Delphinus* is known to feed primarily on organisms in the deep scattering layer, including fish and squid that migrate from depth to surface and back again at different times of day (Evans, 1994). Predation by killer whales on this species has been observed (Leatherwood et al., 1973).

3.7.2.3.12.5 Species-Specific Threats

Long-beaked common dolphins are particularly susceptible to fisheries interactions. From 2007 to 2011, there were 42 known long-beaked common dolphin deaths attributed to human-related causes (primarily gillnet fishery entanglement) (Carretta et al., 2013b). From 2010 to 2014, there were 41 reported fishery-related mortalities of long-beaked common dolphins (Carretta et al., 2016b). Additionally, along California's coast mortality has been documented due to domoic acid toxicity, which is a neurotoxin associated with algal blooms (Carretta et al., 2015).

The 2015 Pacific Stock Assessment Report notes that four long-beaked common dolphins died in 2011 as the result of blast trauma associated with underwater detonations conducted by the U.S. Navy at the Silver Strand Training Complex within the Southern California portion of the HSTT Study Area (Carretta et al., 2017c; Danil & St Leger, 2011). This was the first incident of this kind in decades of conducting training at that location. Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.13 Short-beaked Common Dolphin (*Delphinus delphis*)

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

3.7.2.3.13.1 Status and Management

This species is not listed under the ESA. There is a single Pacific management stock for those animals found within the U.S. Exclusive Economic Zone off the U.S. West Coast, which is called the California, Oregon, and Washington stock (Carretta et al., 2017c).

3.7.2.3.13.2 Habitat and Geographic Range

Short-beaked common dolphins are not present in the Hawaii portion of the HSTT Study Area.

Historically along the U.S. West Coast, short-beaked common dolphins were sighted primarily south of Point Conception (Dohl et al., 1983), but now they are commonly encountered as far north as 42°N (Hamilton et al., 2009), and occasionally as far north as 48°N (Forney, 2007). Seasonal distribution shifts are pronounced, with a significant southerly shift south of Point Arguello, California in the winter (Becker et al., 2014; Campbell et al., 2015; Forney & Barlow, 1998; Henderson et al., 2014a). Short-beaked common dolphins are a warm temperate to tropical species, and based on habitat models developed using line-transect survey data collected off the U.S. West Coast, densities are greatest when waters are warmest (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2014; Becker et al., 2016; Forney & Barlow, 1998; Forney et al., 2012). The abundance of short-beaked common dolphins off the U.S. West Coast varies, 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., 2014; Becker et al., 2016; Forney & Barlow, 1998; Forney et al., 2012; Henderson et al., 2014a). Short-beaked common dolphin abundance off California has increased dramatically since the late 1970s, along with a smaller decrease in abundance in the eastern tropical Pacific, suggesting a large-scale northward shift in the distribution of this species in the eastern North Pacific (Carretta et al., 2017c; Forney et al., 1995; Forney & Barlow, 1998).

Short-beaked common dolphins are found in the Southern California portion of the HSTT Study Area throughout the year, distributed between the coast and approximately 345 mi. from shore (Barlow & Forney, 2007; Barlow, 2016; Forney & Barlow, 1998). Based on multiple line-transect studies conducted by NMFS, the short-beaked common dolphin is the most abundant cetacean species, with a widespread distribution off southern California (Barlow & Forney, 2007; Barlow, 2016; Campbell et al., 2015; Carretta et al., 2011; Douglas et al., 2014; Forney et al., 1995). From 2004 to 2008 during ship surveys conducted quarterly by the state of California off southern California, short-beaked common dolphins were encountered year-round, with highest encounters during the summer (Douglas et al., 2014). From 2008 to 2013 during 18 aerial surveys conducted in the Southern California Bight, short-beaked common dolphins were the most frequently observed cetacean species (Jefferson et al., 2014).

3.7.2.3.13.3 Population Trends

Based on an analysis of sighting data collected during quarterly surveys off southern California from 2004 to 2013, short-beaked common dolphins showed annual variations in density, but there was no significant trend evident during the period of this study (Campbell et al., 2015) or as a result of any other data (Carretta et al., 2017c). However, Barlow (2016) noted a nearly monotonic increase in the abundance of short-beaked common dolphins from 1991 to 2014 off the U.S. West Coast, and suggested that a future trend analysis is appropriate.

3.7.2.3.13.4 Predator and Prey Interactions

Delphinus species fluctuate in vocal activity, with more vocal activity during late evening and early morning, apparently linked to feeding on the deep scattering layer, which rises in this same time frame (Henderson et al., 2012). Predation by killer whales on this species has been observed (Leatherwood et al., 1973).

3.7.2.3.13.5 Species-Specific Threats

Short-beaked common dolphins are particularly susceptible to fisheries interactions and entanglement. From 2007 to 2011, there were 20 known short-beaked common dolphin deaths attributed to human related causes along the U.S. West Coast (primarily gillnet fishery entanglement) (Carretta et al., 2013b). Between 2010 to 2014, there were 24 observed fishery related mortalities to short-beaked common dolphins along the U.S. West Coast (Carretta et al., 2016b) and two serious injuries outside the Exclusive Economic Zone (Bradford & Forney, 2017). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.14 Common Bottlenose Dolphin (*Tursiops truncatus*)

3.7.2.3.14.1 Status and Management

The common bottlenose dolphin is not listed under the ESA. The bottlenose dolphins within the Pacific U.S. Exclusive Economic Zone are divided into seven stocks: (1) Kauai and Niihau, (2) Oahu, (3) the 4-Islands, (4) Hawaii Island, (5) the Hawaii Pelagic stock, (6) California Coastal stock, and (7) the California, Oregon and Washington Offshore stock (Carretta et al., 2017c; Carretta et al., 2018a).

3.7.2.3.14.2 Habitat and Geographic Range

Common bottlenose dolphins typically are found in coastal and continental shelf waters of tropical and temperate regions of the world (Jefferson et al., 2008b; Wells et al., 2009). Common bottlenose dolphins occur throughout the Hawaiian Islands, and they are typically observed throughout the main islands and from the Island of Hawaii to Kure Atoll (Baird, 2013a; Shallenberger, 1981). There were multiple common bottlenose dolphin sightings during both the 2002 (15 sightings) and 2010 (19 sightings) systematic surveys of the Hawaiian Exclusive Economic Zone (Barlow, 2006; Bradford et al., 2013). In the Hawaiian Islands, this species is found in both shallow coastal waters and deep offshore waters (Baird et al., 2003b; Barlow et al., 2008; Bradford et al., 2013; Mobley et al., 2000). Passive acoustic monitoring at the Puuloa Range adjacent to the Pearl Harbor entrance documented a very low number of odontocete whistle detections, consistent with the relatively shallow coastal shelf bathymetry and preferred odontocete foraging behavior (Shannon et al., 2016). The offshore variety is typically larger than the inshore. Bottlenose dolphins were observed during Navy monitoring surveys at Kaula Island in 2000, 2003, and 2009–2011 (Richie et al., 2012). Habitat-based models developed from systematic ship survey data collected in the central North Pacific show some of the highest common bottlenose dolphin densities around the Hawaiian Islands (Becker et al., 2012b; Forney et al., 2015). Twelve stranding records from the main Hawaiian Islands exist (Maldini, 2003; Maldini et al., 2005).

Photo-identification and genetics indicate the presence of island- associated populations of bottlenose dolphins in the Hawaiian Islands (Martien et al., 2012). Four broad areas covering the main Hawaiian Islands have been identified for Small and Resident Populations of bottlenose dolphins (Baird et al., 2015a). These delineated areas are based on the range for each of the four recognized stocks around each island region, with the offshore extent defined by the 1,000 m depth contour (Baird et al., 2015a). A more detailed analysis of the area has been presented in Appendix K (Geographic Mitigation Assessment).

Common bottlenose dolphins are known to occur year round in both coastal and offshore waters of Monterey Bay, Santa Monica Bay, San Diego Bay, and San Clemente Island, California (Bearzi, 2005a, 2005b; Bearzi et al., 2009; Carretta et al., 2000; Henkel & Harvey, 2008). In the Southern California portion of the Study Area, they are routinely encountered in San Diego Bay, transiting to the waters off Coronado where they feed (Graham & Saunders, 2015).

During surveys off California, offshore common bottlenose dolphins were generally found at distances greater than 1.9 mi. from the coast and throughout the waters of Southern California (Barlow & Forney, 2007; Barlow, 2016; Bearzi et al., 2009; Hamilton et al., 2009). Sighting records off California and Baja California suggest a continuous distribution of offshore common bottlenose dolphins in these regions (Mangels & Gerrodette, 1994). Analyses of sighting data collected during winter aerial surveys in 1991–1992 and summer shipboard surveys in 1991 indicated no significant seasonal shifts in distribution (Forney & Barlow, 1998). Based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast, offshore common bottlenose dolphins exhibit a disjunctive longitudinal distribution, suggesting that there may be two separate populations in this area, although additional genetic data are required for confirmation (Becker et al., 2016).

Off Southern California, animals are found within 500 m of the shoreline 99 percent of the time and within 250 m of the shoreline 90 percent of the time (Hanson & Defran, 1993; Hwang et al., 2014). California coastal bottlenose dolphins are found generally from Point Conception to as far south as San Quintin, Mexico (Carretta et al., 1998; Defran & Weller, 1999; Hwang et al., 2014). Coastal common bottlenose dolphins also have been consistently sighted off central California and as far north as San Francisco since the 1983 El Niño, when they apparently traveled further north tracking prey due to the northern extent of warmer waters and continued using those more northern waters after that El Niño had ended (Hwang et al., 2014). In the fall of 2017, a group of bottlenose dolphins was sighted repeatedly in Puget Sound, which was 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, 2017). One animal in the group was photo identified as a well-known dolphin first sighted in southern California in 1983, belonging to the 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, 2017). The dolphins in the nearshore waters of San Diego, California, differ somewhat from other coastal populations of this species in distribution, site fidelity, and pod size (Bearzi, 2005a, 2005b; Carretta et al., 2017c; Defran & Weller, 1999; Defran et al., 2015). Photo identification analyses suggest that there may be two separate stocks of coastal bottlenose dolphins that exhibit limited integration, a California Coastal stock and a Northern Baja California stock (Defran et al., 2015), but they are not yet managed by NMFS as two stocks (Carretta et al., 2017c). The results from relatively contemporaneous surveys at Ensenada, San Diego, Santa Monica Bay, and Santa Barbara between 1996 and 2001 provided samples of the speed and distances individual coastal bottlenose dolphins routinely traveled (Hwang et al., 2014). The minimum travel speed observed as 53 km per day and the maximum was 95 km per day and the total distances traveled between points was between 104 km and 965 km (Hwang et al., 2014).

3.7.2.3.14.3 Population Trends

For the Hawaiian Islands Stock Complex of common bottlenose dolphins, stock-specific abundance numbers and description of the boundary between the pelagic and insular stocks of bottlenose dolphin in Hawaii have been presented in the most recent (2017) Pacific Stock Assessment Report (Carretta et al., 2017c; Carretta et al., 2017d). For the Hawaii Pelagic stock, the abundance was estimated based on the 2010 survey; however, NMFS has determined that the survey information is outdated for the four island-associated insular stocks (Kauai and Niihau, Oahu, 4-Islands, and Hawaii Island), so for those populations there is no current abundance estimate available (Carretta et al., 2017d).

For the Southern California portion of the HSTT Study Area, the California Coastal stock population size has remained stable over the period for which data are available (Carretta et al., 2017c; Dudzik et al., 2006). For the California, Oregon and Washington Offshore stock, there has been no trend analysis for the population (Carretta et al., 2017c).

3.7.2.3.14.4 Predator and Prey Interactions

Common bottlenose dolphins are opportunistic feeders, taking a wide variety of fishes, cephalopods, shrimps (Wells & Scott, 1999), and using a variety of feeding strategies (Shane, 1990). As with all odontocetes, bottlenose dolphins use echolocation for locating prey and also likely detect and orient to fish prey by passively listening for the sounds their prey produce (Barros & Myrberg, 1987; Barros & Wells, 1998). Coastal bottlenose dolphins prey predominantly on coastal fish and cephalopods, while offshore individuals prey on open-ocean cephalopods and a large variety of near-surface and mid-water fish species (Mead & Potter, 1995). Pacific coast bottlenose dolphins feed primarily on surf perches (family Embiotocidae) and croakers (family Sciaenidae) (Wells & Scott, 1999). Throughout its range this species is known to be preyed on by killer whales and sharks (Wells & Scott, 2009).

3.7.2.3.14.5 Species-Specific Threats

Common bottlenose dolphins are particularly susceptible to entanglement and other interactions with fishery operations. In Hawaii from 2011 to 2015, longline fisheries were observed interacting with 14 bottlenose dolphins (Bradford & Forney, 2017) and there was one case of a dolphin with a trolling hook in its mouth (Bradford & Lyman, 2015). From 2007 to 2011, there were two known bottlenose dolphin deaths attributed to human-related causes along the U.S. West Coast, and between 2010 to 2014 there were four deaths as a result of fishery interactions (Carretta et al., 2013b; Carretta et al., 2016b). Morbillivirus has been detected in bottlenose dolphins in Hawaii (Jacob et al., 2016). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.15 Pantropical Spotted Dolphin (*Stenella attenuata*)

3.7.2.3.15.1 Status and Management

The species is not listed under the ESA. For the NMFS stock assessment reports, the species has been divided into four stocks based on genetics and the frequency of sightings in pelagic waters around Hawaii (Courbis et al., 2014; Oleson et al., 2013). For the NMFS stock assessment reports, the four management stocks within the Hawaiian Islands Exclusive Economic Zone are (1) the Oahu stock, which includes spotted dolphins within 20 km of Oahu; (2) the 4-Islands stock, which includes spotted dolphins within 20 km of the island group formed by Maui, Molokai, Lanai, and Kahoolawe and their adjacent waters; (3) the Hawaii Island stock, which includes spotted dolphins found within 65 km from Hawaii

Island; and (4) the Hawaii Pelagic stock, which includes spotted dolphins inhabiting the waters throughout the Hawaiian Islands Exclusive Economic Zone outside of the insular stock areas (Carretta et al., 2017c).

3.7.2.3.15.2 Habitat and Geographic Range

The pantropical spotted dolphin is distributed in offshore tropical and subtropical waters of the Pacific, Atlantic, and Indian Oceans between about 40° N and 40° S (Baldwin et al., 1999; Perrin, 2009b). The species is much more abundant in the lower latitudes of its range. It is found mostly in deeper offshore waters but does approach the coast in some areas (Jefferson et al., 2008b; Perrin, 2001).

Based on sightings during small boat surveys from 2000 to 2012 in the main Hawaiian Islands, pantropical spotted dolphins were the most abundant species of cetacean, although they were frequently observed leaping out of the water which likely increased their detectability (Baird, 2013a). This species was also one of the most abundant based on analyses of line-transect data collected in the Hawaiian Exclusive Economic Zone in 2002 and 2010 (Barlow, 2006; Bradford et al., 2013). Known habitat preferences and sighting data indicate the primary occurrence for the pantropical spotted dolphin in Hawaiian waters is in shallow coastal waters to depths of 5,000 m, although the peak sighting rates occur in depths from 1,500 to 3,500 m (Baird et al., 2013c; Bradford et al., 2013; Oleson et al., 2013). Habitat-based models developed from systematic ship survey data collected in the central North Pacific show relatively high pantropical spotted dolphin densities around the Hawaiian Islands, particularly around the main Hawaiian Islands (Becker et al., 2012a; Forney et al., 2015), consistent with sightings from two systematic ship surveys of the Hawaiian Exclusive Economic Zone (Barlow 2006; (Bradford et al., 2017).

A year-round biologically important small and resident population area has been identified for pantropical spotted dolphins around the main Hawaiian Islands (Baird et al., 2015a). Sighting data from small-boat surveys were used to delineate the three locations forming this area but these data are biased by survey effort that has occurred mainly off the protected leeward sides of the Hawaiian Islands (Baird et al., 2015a). A more detailed analysis of the area has been presented in Appendix K.

Pantropical spotted dolphins are not present in the Southern California portion of the HSTT Study Area.

3.7.2.3.15.3 Population Trends

Data from a 2010 shipboard line-transect survey has provided for an abundance estimate of 55,795 (CV = 0.40) spotted dolphins in the Hawaii pelagic stock (Bradford et al., 2017; Carretta et al., 2017d). There is no data available on current population trend for any of the island-associated resident stocks of pantropical spotted dolphins in Hawaii (Carretta et al., 2017c; Carretta et al., 2017d).

3.7.2.3.15.4 Predator and Prey Interactions

Pantropical spotted dolphins prey on near-surface fish, squid, and crustaceans and on some mid-water species (Perrin & Hohn, 1994). Results from various tracking and feeding studies suggest that pantropical spotted dolphins in the eastern tropical Pacific and off Hawaii feed primarily at night on surface and mid-water species that rise with the deep scattering layer toward the water's surface after dark (Baird et al., 2001; Silva et al., 2016). Pantropical spotted dolphins may be preyed on by killer whales and sharks, and have been observed fleeing killer whales in Hawaiian waters (Baird et al., 2006b). Other predators may include the pygmy killer whale, false killer whale, and occasionally the short-finned pilot whale (Perrin, 2009b).

3.7.2.3.15.5 Species-Specific Threats

Even though bycatch has been reduced for tuna purse seine fisheries, interactions may have negative effects on species survival and reproduction (Archer et al., 2010). Pantropical spotted dolphins in Hawaii have been observed interacting with the longline fishery resulting in injury (Bradford & Forney, 2014), and there was one case of serious injury to a spotted dolphin observed entangled in fishing line (Bradford & Lyman, 2015). Morbillivirus has been detected in pantropical spotted dolphins in Hawaii (Jacob et al., 2016). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.16 Striped Dolphin (*Stenella coeruleoalba*)

3.7.2.3.16.1 Status and Management

This species is not listed under the ESA. In the eastern north Pacific, NMFS identifies two striped dolphin management stocks within the U.S. Exclusive Economic Zone: the Hawaiian stock and the California, Oregon, and Washington stock (Carretta et al., 2017c).

3.7.2.3.16.2 Habitat and Geographic Range

Although primarily a warm-water species, the range of the striped dolphin extends higher into temperate regions than that 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. In some areas (e.g., the eastern tropical Pacific), they are mostly associated with convergence zones and regions of upwelling (Au & Perryman, 1985; Reilly, 1990). The northern limits are the Sea of Japan, Hokkaido, Washington State, and along roughly 40° N across the western and central Pacific (Reeves et al., 2002b). In the eastern tropical Pacific, striped dolphins inhabit areas with large seasonal changes in surface temperature and thermocline depth, as well as seasonal upwelling (Au & Perryman, 1985; Reilly, 1990). In some areas, this species appears to avoid waters with sea temperatures less than 68°F (20°C) (Van Waerebeek et al., 1998).

The striped dolphin regularly occurs around the Hawaiian Islands. Two comprehensive shipboard surveys of the Hawaiian U.S. Exclusive Economic Zone resulted in 15 sightings of striped dolphins in 2002 (Barlow, 2006) and 25 sightings in 2010 (Bradford et al., 2017). Resulting density estimates from these surveys suggest that they are one of the most abundant cetacean species in the Hawaiian Exclusive Economic Zone. Based on sighting records, this species occurs primarily seaward of the 1,000-m depth contour. Striped dolphins are occasionally sighted closer to shore in Hawaii, so an area of secondary occurrence is expected from a depth range of 100 to 1,000 m. The available occurrence data do not suggest any island-associated populations for this species (Baird et al., 2016). Occurrence patterns are assumed to be the same throughout the year (Mobley et al., 2000). Habitat-based models developed from systematic ship survey data collected in the central North Pacific show more uniform striped dolphin densities throughout the Hawaiian Exclusive Economic Zone, consistent with this species' known occurrence in deep waters (Becker et al., 2012b; Forney et al., 2015).

Based on sighting records, striped dolphins appear to have a continuous distribution in offshore waters from California to Mexico (Mangels & Gerrodette, 1994). The striped dolphin also occurs far offshore, in waters affected by the warm Davidson Current as it flows northward (Archer, 2009; Jefferson et al., 2008b). During ship surveys conducted off the U.S. West Coast in the summer and fall from 1991 to 2005, striped dolphins were sighted primarily from 100 to 300 NM offshore of the California coast (Barlow & Forney, 2007). Striped dolphin encounters increase in deep, relatively warmer waters off the U.S. West Coast (Becker et al., 2012a; Becker et al., 2016; Henderson et al., 2014a), and their abudance decreases north of about 42°N (Barlow et al., 2009; Becker et al., 2012a; Becker et al., 2016; Forney et al., 2012). There were only three striped dolphin encounters during 16 ship surveys off southern California from 2004 to 2008 (Douglas et al., 2014) and they were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea, 2014).

3.7.2.3.16.3 Population Trends

Data from a 2010 shipboard line-transect survey has provided for an abundance estimate of 61,021 (CV = 0.38) spotted dolphins in the Hawaii pelagic stock (Bradford et al., 2017; Carretta et al., 2017d). NMFS has determined that an assessment of population trend will likely require additional survey data for the species (Carretta et al., 2017d).

For the California, Oregon, and Washington stock of striped dolphins, no long-term trends in abundance have been identified for this stock (Carretta et al., 2017c). Since a large portion of the striped dolphin population is present beyond both the U.S. EEZ and the area covered by NMFS surveys (Gerrodette et al., 2008; National Marine Fisheries Service, 2016h), the actual abundance of striped dolphins in the HSTT Study Area is higher than presented in the stock assessment report for the portion of the population represented by the California, Oregon, and Washington stock.

3.7.2.3.16.4 Predator and Prey Interactions

Striped dolphins often feed in open sea or sea bottom zones along the continental slope or just beyond it in oceanic waters. Most of their prey possess light-emitting organs, suggesting that striped dolphins may be feeding at great depths, possibly diving to 200 to 700 m (Archer & Perrin, 1999). Striped dolphins may feed at night in order to take advantage of the deep scattering layer's diurnal vertical movements. Small mid-water fishes (in particular lanternfishes) and squids are the predominant prey (Perrin et al., 1994b). This species has been documented to be preyed upon by sharks (Ross & Bass, 1971). It may also be subject to predation by killer whales.

3.7.2.3.16.5 Species-Specific Threats

In Hawaii between 2010 and 2014 for striped dolphins, there were six observed interactions and one serious injury from a longline fishery interaction (Bradford & Forney, 2017). From 2007 to 2014, there was one human-caused death of a striped dolphin along the U.S. West Coast (Carretta et al., 2013b; Carretta et al., 2016b). Two stranded striped dolphins in Hawaii have tested positive for morbillivirus and another was found to have the bacterial infection brucella; the prevalence of these diseases in the general striped dolphin population is not known at the present time (Carretta et al., 2017d; Jacob et al., 2016). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.17 Spinner Dolphin (*Stenella longirostris*)

Four well-differentiated geographical forms of spinner dolphins have been described as separate subspecies but only *Stenella longirostris* (Gray's spinner dolphin) is present in the HSTT Study Area (Leslie & Morin, 2018).

3.7.2.3.17.1 Status and Management

The spinner dolphin is not listed under the ESA. The eastern spinner dolphin (*Stenella longirostris orientalis*) is listed as depleted under the MMPA. Under the MMPA, there are six stocks found within the U.S. Exclusive Economic Zone of the Hawaiian Islands: (1) Hawaii Island, (2) Oahu/4-Islands, (3) Kauai/Niihau, (4) Pearl & Hermes Reef, (5) Kure/Midway, and (6) Hawaii Pelagic, including animals found both within the Hawaiian Islands Exclusive Economic Zone (outside of island-associated boundaries) and in adjacent international waters (Carretta et al., 2013a; Carretta et al., 2017c; Carretta et al., 2018b).

3.7.2.3.17.2 Habitat and Geographic Range

Spinner dolphins occur in both oceanic and coastal environments and seasonal movement patterns for this species have not been documented. Spinner dolphins are pantropical, ranging through oceanic tropical and subtropical zones in both hemispheres (Jefferson et al., 2015). Based on an analysis of individual spinner dolphin movements in Hawaii, no spinner dolphins from the island-associated stocks have been found farther than 10 NM from shore and few individuals move long distances (from one main Hawaiian Island to another) (Hill et al., 2011). Open-ocean populations, such as the Hawaii Pelagic stock or those animals in the eastern tropical Pacific, often are found in waters with a shallow thermocline (rapid temperature difference with depth) (Au & Perryman, 1985; Perrin, 2009c; Reilly, 1990). The thermocline concentrates open-sea organisms in and above it, which spinner dolphins feed on. In the eastern tropical Pacific, spinner dolphins are associated with tropical surface waters typified by extensive stable thermocline ridging and relatively little annual variation in surface temperature (Au & Perryman, 1985; Perrin, 2009c).

In the Hawaiian Islands, spinner dolphins occur along the leeward coasts of all the major islands and around several of the atolls northwest of the main Hawaiian Islands. Spinner dolphins occur year round throughout the Hawaiian Islands, with primary occurrence from the shore to the 4,000 m depth. This takes into account nearshore resting habitat and offshore feeding areas. Spinner dolphins are expected to occur in shallow water resting areas (about 50 m deep or less) throughout the middle of the day, moving into deep waters offshore during the night to feed (Heenehan et al., 2016b; Heenehan et al., 2017; Norris & Dohl, 1980). Some of these resting areas are in proximity to upwellings or bathymetric features that result in localized concentration of spinner dolphin prey (Giorli & Au, 2017; Giorli et al., 2018). For example, there is an escarpment off Hawaii Island’s Keahole Point that produces a locally enriched area that spinner dolphins exploit during nightly foraging trips from the nearby Makako Bay (Heenehan et al., 2017; Norris et al., 1994). Primary resting areas are along the west side of Hawaii, including Makako Bay, Honokohau Bay, Kailua Bay, Kealakekua Bay, Honaunau Bay, and Kauhako Bay, and off Kahena on the southeast side of the island (Heenehan et al., 2016b; Heenehan et al., 2017; Norris & Dohl, 1980; Östman-Lind et al., 2004; Tyne et al., 2015; Tyne et al., 2017). Along the Waianae coast of Oahu, Hawaii, spinner dolphins rest along Makua Beach, Kahe Point, and Pokai Bay during the day (Lammers, 2004). Kilauea Bay on Kauai is also a popular resting areas for Hawaiian spinner dolphins (U.S. Department of the Navy, 2006). Monitoring for the Rim of the Pacific Exercise in 2006 resulted in daily sightings of spinner dolphins within the offshore area of Kekaha Beach, Kauai, near the Pacific Missile Range Facility (U.S. Department of the Navy, 2006). Spinner dolphins have been observed during Navy monitoring surveys at Kaula Island in 2000, 2003, and 2009-2011 (Richie et al., 2012). Although sightings have been recorded around the mouth of Pearl Harbor, Hawaii, spinner dolphin occurrence is rare there (Lammers, 2004; Richie et al., 2016; Shannon et al., 2016). Occurrence patterns are assumed to be the same throughout the year. Habitat-based models developed from systematic ship survey data collected in the central North Pacific show the strong island association of spinner dolphins (Becker et al., 2012b; Forney et al., 2015), consistent with previously documented distribution patterns (Barlow, 2006).

A number of biologically important small and resident population areas have been identified for spinner dolphins in the Hawaiian Islands (Baird et al., 2015a). These delineated areas are based on the range for each of the five recognized stocks and extend 10 NM from the shore of the Islands for which stock is named (Baird et al., 2015a). A more detailed analysis of the area has been presented in Appendix K (Geographic Mitigation Assessment).

Spinner dolphins are not present in the Southern California portion of the HSTT Study Area.

3.7.2.3.17.3 Population Trends

For spinner dolphins in Hawaii, differences in survey methodologies or insufficient data have precluded an assessment of any population trend for any of the six identified stocks (Carretta et al., 2017c; Carretta et al., 2018b).

3.7.2.3.17.4 Predator and Prey Interactions

Spinner dolphins feed primarily on small mid-water fishes, squids, and shrimp, and they dive to at least 200 to 300 m (Perrin & Gilpatrick, 1994). They forage primarily at night, when the mid-water community migrates toward the surface and the shore (Benoit-Bird et al., 2001; Benoit-Bird, 2004). Spinner dolphins track the horizontal and vertical migrations of their prey (Benoit-Bird & Au, 2003), allowing for foraging efficiencies (Benoit-Bird & Au, 2003; Benoit-Bird, 2004). Foraging behavior has also been linked to lunar phases in scattering layers off of Hawaii (Benoit-Bird & Au, 2004). Spinner dolphins may be preyed on by sharks, killer whales, pygmy killer whales, and short-finned pilot whales (Perrin, 2009c).

3.7.2.3.17.5 Species-Specific Threats

Bradford and Lyman (2015) report that from 2008 to 2012 there were three observed serious injuries (leading to death) to spinner dolphins in Hawaii. Two of these injuries were fishing-related and one involved marine debris preventing the individual’s mouth from opening.

In 2015, a spinner dolphin stranded at a beach on Hawaii Island’s Kohala coast and was found to have parasitic toxoplasmosis from feral cats as the case of death (Rogers, 2016). The prevalence of this parasite as a threat to spinner dolphins in Hawaii is not yet known, but there has since been another case of this parasite discovered in the species (Barbieri et al., 2017).

Spinner dolphins in Hawaii are also subjected to chronic disturbance in their resting habitats from tourism that may have negative, long-term impacts (Courbis & Timmel, 2009; Heenehan et al., 2016a; Heenehan et al., 2017; Tyne et al., 2014; Tyne, 2015; Tyne et al., 2015; Tyne et al., 2017). Courbis (2009) found changes in spinner dolphin aerial behaviors and suggested it was likely that vessel and swimmer activity was at least synergistically involved in causing these changes, but whether the behavioral changes affected the survival and fitness of spinner dolphins remains unknown. Following a subsequent analysis, Tyne (2015) recommended that management actions be taken to keep the spinner dolphin resting areas free from human activities. As a result of the findings noted above, NMFS has proposed regulations to protect spinner dolphins from these types of disturbance related adverse impacts (National Marine Fisheries Service, 2016d, 2016e).Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.18 Rough-toothed Dolphin (*Steno bredanensis*)

3.7.2.3.18.1 Status and Management

This species is not listed under the ESA. Rough-toothed dolphins are among the most widely distributed species of tropical dolphins (Jefferson et al., 2015). There is a single Pacific management stock for rough-toothed dolphins found within the U.S. Exclusive Economic Zone of the Hawaiian Islands, but there is no recognized stock of rough-toothed dolphins for the U.S. West Coast (Carretta et al., 2017c)

3.7.2.3.18.2 Habitat and Geographic Range

Rough-toothed dolphins are well known in deep ocean waters off the Hawaiian Islands but are also seen relatively frequently during nearshore surveys (Baird et al., 2008a; Baird et al., 2015c; Barlow et al., 2008; Bradford et al., 2013; Carretta et al., 2015; Pitman & Stinchcomb, 2002; Shallenberger, 1981; Webster et al., 2015). During NMFS' 2010 survey of the Hawaiian Islands, this species was encountered 24 times and has been observed as far northwest as Pearl and Hermes Reef in the Northwest Hawaiian Islands (Bradford et al., 2013). Habitat-based models developed from systematic ship survey data collected in the central North Pacific show the strong island association of rough-toothed dolphins (Becker et al., 2012b; Forney et al., 2015). Over a 10-day near-shore survey effort off Kauai in 2014, rough-toothed dolphins were encountered on two occasions and 7 of the 8 individuals photo-identified had been observed in previous years (Baird et al., 2015b). Data from 14 satellite tags deployed off Kauai between 2011–2015 on rough-toothed dolphins indicated a large portion of the core area for those animals overlaps the Pacific Missile Range Facility range and the channel between Kauai and Niihau (Baird et al., 2015b). The data presented by Baird et al. (2015b) and Webster et al. (2015) are indicative of residency on or near the Pacific Missile Range Facility range by some of those animals (see also (Baird et al., 2008a). Because there are insufficient data at present, the area has not been identified as a biologically important area for this small resident population off Kauai (Baird et al., 2015a).

Unpublished data from small boat surveys off the West Coast of Hawaii Island between 2002–2014 have provided sighting locations and genetic evidence indicative of another resident population, resulting in the identification of a biologically important area for that population (Baird et al., 2015a). The delineated area is a rough triangle encompassing all the locations where rough-toothed dolphins were sighted during those surveys (Baird et al., 2015a). A more detailed analysis of the area has been presented in Appendix K.

Using genetic samples obtained from rough toothed dolphins in the Hawaiian Islands and islands in Samoa and French Polynesia, the Central Pacific population structure in rough-toothed dolphins was found to consist of multiple insular Pacific populations and island-specific genetically isolated insular populations attached to islands in each archipelago (Albertson et al., 2011). These findings are consistent with a growing body of evidence that pelagic species form isolated insular populations in areas with increased local productivity (Albertson et al., 2011).

Rough-toothed dolphins are not expected to be present in the Southern California portion of the HSTT Study Area. The range of the rough-toothed dolphin is known to include the southern portion of the California coast but there is no recognized stock for the U.S. West Coast (Carretta et al., 2015). Several strandings were documented for this species in central and Southern California between 1977 and 2002 (Zagzebski et al., 2006). This species has not been observed during seven systematic ship surveys from 1991 to 2014 off the U.S. West Coast (Barlow, 2016). During 16 quarterly ship surveys off southern California from 2004 to 2008, there was one encounter with a group of 9 rough-toothed dolphins, which was considered an extralimital occurrence (Douglas et al., 2014).

3.7.2.3.18.3 Population Trends

The large abundance difference between the 2002 and 2010 survey-based estimates and the overlapping confidence intervals for rough-toothed dolphins preclude assessment of population trends with the available data (Carretta et al., 2017c).

3.7.2.3.18.4 Predator and Prey Interactions

Prey of rough-toothed dolphins includes fish and cephalopods. They are known to feed on large fish species, such as mahi mahi (Miyazaki & Perrin, 1994; Pitman & Stinchcomb, 2002). They may also prey on reef fish, as Perkins and Miller (1983) noted that parts of reef fish had been found in the stomachs of stranded rough-toothed dolphins in Hawaii, although the stomach contents of a stranded animal may not be representative for the species. Gannier and West (2005) observed rough-toothed dolphins feeding during the day on near-surface fishes, including flying fishes.

Although this species has not been documented as prey by other species, it may be subject to predation from killer whales.

3.7.2.3.18.5 Species-Specific Threats

From 2010 to 2014, two rough-toothed dolphins were observed injured during shallow-set longline fisheries in the Hawaiian Exclusive Economic Zone (Bradford & Forney, 2017) and one was observed entangled in gear (Carretta et al., 2017d). One stranded rough-toothed dolphin in Hawaii has tested positive for morbillivirus and another was found to have the bacterial infection brucella; the prevalence of these diseases in the general population is not known at the present time (Carretta et al., 2017d). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.19 Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

3.7.2.3.19.1 Status and Management

This species is not listed under the ESA. NMFS recognizes a single stock for the U.S. West Coast, the California, Oregon, and Washington stock (Carretta et al., 2017c).

3.7.2.3.19.2 Habitat and Geographic Range

Pacific white-sided dolphins are not present in the Hawaii portion of the HSTT Study Area.

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 (Ferguson, 2005; Jefferson et al., 2015; Leatherwood et al., 1984; Reeves et al., 2002b). They are also known to inhabit inshore regions of southeast Alaska, British Columbia, and Washington, and occurs seasonally off Southern California (Brownell et al., 1999; Forney & Barlow, 1998). Sighting records and captures in open sea driftnets indicate that this species also occurs in oceanic waters well beyond the shelf and slope (Ferrero & Walker, 1996; Leatherwood et al., 1984).

Off California, Forney and Barlow (1998) found significant north/south shifts in the seasonal distribution of Pacific white-sided dolphin, with animals moving north into Oregon and Washington waters during the summer, and showing increased abundance in the Southern California Bight in the winter. During ship surveys conducted off the U.S. West Coast in the summer and fall from 1991 to 2005, the number of Pacific white-sided dolphin sightings showed no clear pattern with respect to geographic region, although they were consistently found in larger groups off central California (Barlow & Forney, 2007; Henderson et al., 2014a). Based on habitat models developed with survey data collected during summer and fall from 1991 to 2009, Becker et al. (2016) found that encounters of Pacific white-sided dolphin increased in shelf and slope waters and in relatively cooler waters in the study area. These patterns are consistent with previous habitat modeling efforts using a subset of the same data (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012b; Becker et al., 2014; Forney et al., 2012). Based on ship survey data collected quarterly from 2004 to 2013, Pacific white-sided dolphins occurred year-round off southern California, but the majority of the sightings were in winter and spring when their distribution was more widespread (Campbell et al., 2015). There were 21 sightings of Pacific white-sided dolphin during 18 aerial surveys conducted in the southern California Bight from 2008 to 2013 (Jefferson et al., 2014).

3.7.2.3.19.3 Population Trends

Multiple analyses of sightings and stranding data have indicated a significant decline in abundance over time from the Southern California Bight to the Gulf of California in Mexico (Barlow, 2016; Campbell et al., 2015; Salvadeo et al., 2010; Smultea, 2014).

3.7.2.3.19.4 Predator and Prey Interactions

Pacific white-sided dolphins in the eastern north Pacific feed primarily on near-surface and mid-water fishes, such as lanternfish, anchovies, mackerel, and hake, as well as cephalopods (Black, 1994; Brownell et al., 1999; Heise, 1997; Jefferson et al., 2008b; Morton, 2000). Feeding appears to be mostly on deep scattering layer organisms by use of cooperative feeding methods (Black, 2009; Jefferson et al., 2008b). Large schools have been observed feeding cooperatively on large shoals of schooling fish (Black, 2009; Jefferson et al., 2008b). Pacific white-sided dolphins have been observed being preyed on by killer whales and typically flee when they come in contact with the predator (Black, 2009).

3.7.2.3.19.5 Species-Specific Threats

Pacific white-sided dolphins are particularly susceptible to entanglement and other fishery interactions. Along the U.S. West Coast from 2007 to 2012 there were 35 human related deaths of and 4 serious injuries to Pacific white-sided dolphins (Carretta et al., 2013b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.20 Northern Right Whale Dolphin (*Lissodelphis borealis*)

3.7.2.3.20.1 Status and Management

This species it is not listed under the ESA but is protected by the MMPA. The management stock in U.S. waters consists of a single California, Oregon, and Washington stock (Carretta et al., 2017c).

3.7.2.3.20.2 Habitat and Geographic Range

The northern right whale dolphin occurs in cool and temperate to subarctic waters of the North Pacific, from the West Coast of North America to Japan and Russia. This oceanic species is distributed from approximately 30°N to 50°N, 145°W to 118°E and generally not as far north as the Bering Sea (Jefferson et al., 2015). Occasional movements south of 30°N are associated with unusually cold water temperatures (Jefferson & Lynn, 1994). This species tends to occur along the outer continental shelf and slope, normally in waters colder than 68°F (20°C) (Jefferson & Lynn, 1994). Northern right whale dolphins generally move nearshore only in areas where the continental shelf is narrow or where productivity on the shelf is especially high (Smith et al., 1986).

Northern right whale dolphins are not present in the Hawaii portion of the HSTT Study Area.

Off California, the northern right whale dolphin is known to occur year round, but abundance and distribution vary seasonally (Becker et al., 2014; Dohl et al., 1983; Douglas et al., 2014; Forney & Barlow, 1998). Northern right whale dolphins are primarily found off California during the colder water months, with distribution shifting northward into Oregon and Washington as water temperatures increase during late spring and summer (Barlow, 1995; Forney et al., 1995; Forney & Barlow, 1998; Henderson et al., 2014a). In the cool water period, the peak abundance of northern right whale dolphins in the Southern California portion of the Study Area corresponds closely with the peak abundance of squid (Forney & Barlow, 1998; Jefferson & Lynn, 1994). Northern right whale dolphins were sighted year-round during 16 ship surveys conducted from 2004 to 2008 off southern California, but the majority of the sightings were in winter and spring (Douglas et al., 2014). There were 16 sightings of northern right whale dolphins during 18 aerial surveys conducted in the southern California Bight from 2008 to 2013 (Jefferson et al., 2014).

As noted above, in the warm water periods, the northern right whale dolphin is not as abundant in Southern California due to shifting distributions north into Oregon and Washington (Barlow, 1995; Forney et al., 1995; Forney & Barlow, 1998). 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). These patterns are consistent with previous habitat modeling efforts using a subset of the same data (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012b; Becker et al., 2014; Forney et al., 2012). Northern right whale dolphins also tend to occur further offshore of southern California during the summer months (Douglas et al., 2014; Forney & Barlow, 1998).

3.7.2.3.20.3 Population Trends

Examination of sighting and stranding data from the 1950s through 2012 suggest that the relative occurrence of northern right whale dolphins in the Southern California Bight has not changed over that period (Smultea, 2014) and the Pacific Stock Assessment Report states that there is no evidence of a trend in abundance for this stock (Carretta et al., 2017c).

3.7.2.3.20.4 Predator and Prey Interactions

Northern right whale dolphins are known to feed on a wide variety of near-surface and mid-water prey species, including fishes and cephalopods, such as squid. Otolith (earbone) identification has shown that the northern right whale dolphin preys on many different species. Squid and lanternfish appear to be the main prey species in Southern California waters (Jefferson et al., 2015). This species may be preyed on by killer whales and occasionally sharks (Lipsky, 2009).

3.7.2.3.20.5 Species-Specific Threats

Northern right whale dolphins are particularly susceptible to entanglement and other fishery interactions such as purse seines and driftnets (Jefferson et al., 2015). The major threat appears to be bycatch in the California/Oregon thresher shark driftnet fishery, but catches are low, only about five to nine individuals per year (Carretta et al., 2010). From 2007 to 2014 there were 13 known northern right whale dolphins deaths attributed to human-related causes along the U.S. West Coast (Carretta et al., 2013b; Carretta et al., 2016b). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.21 Fraser's Dolphin (*Lagenodelphis hosei*)

Since its discovery in 1956, Fraser's dolphin was known only from skeletal specimens until it was once again identified in the early 1970s (Perrin et al., 1973). Although still one of the least-known species of cetaceans, Fraser's dolphin has become much better described as a species in recent years.

3.7.2.3.21.1 Status and Management

Fraser's dolphin is not listed under the ESA. For the MMPA stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands (Carretta et al., 2010; Carretta et al., 2017c).

3.7.2.3.21.2 Habitat and Geographic Range

In the offshore eastern tropical Pacific, this species is distributed mainly in upwelling-modified waters (Aguayo & Sanchez, 1987; Au & Perryman, 1985; Ferguson, 2005; Miyazaki & Wada, 1978; Reilly, 1990).

Fraser's dolphins have been documented within Hawaiian waters, with the first published sightings occurring during a 2002 cetacean survey (Barlow, 2006). Fraser's dolphin vocalizations have also been documented in the Hawaiian Islands (Barlow et al., 2004; Barlow et al., 2008). Based on line-transect survey data collected in summer/fall of 2010, Fraser's dolphin was one of the most abundant species within the Exclusive Economic Zone ocean areas around the Hawaiian Islands; having a notably large group size in the pods observed with a mean of 283 animals (Bradford et al., 2013). In small boat surveys nearshore around the Hawaiian Islands, Fraser's dolphins have only been seen twice in 10 years (both times off the Kona Coast of Hawaii Island) (Baird, 2013a). It is not known whether Fraser's dolphins found in Hawaiian waters are part of the same population that occurs in the eastern tropical Pacific (Carretta et al., 2010). There are no records for strandings of this species in the Hawaiian Islands (Maldini et al., 2005; National Marine Fisheries Service, 2015c).

Fraser's dolphins are not present in the Southern California portion of the HSTT Study Area.

3.7.2.3.21.3 Population Trends

Data from a 2010 shipboard line-transect survey has provided an abundance estimate of 51,491 (CV = 0.66) Fraser's dolphins in the Hawaii stock (Bradford et al., 2017; Carretta et al., 2017d). NMFS has determined that assessment of the population trend will likely require additional survey data for the species (Carretta et al., 2017d).

3.7.2.3.21.4 Predator and Prey Interactions

Fraser's dolphins feed on mid-water fishes, squids, and shrimps and has not been documented to be prey to any other species (Jefferson & Leatherwood, 1994; Perrin et al., 1994a).

3.7.2.3.21.5 Species-Specific Threats

There are no known significant species-specific threats to Fraser's dolphins in the Study Area. Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.22 Risso's Dolphin (*Grampus griseus*)

3.7.2.3.22.1 Status and Management

Risso's dolphin is not listed under the ESA. For the NMFS stock assessment reports, Risso's dolphins within the Pacific U.S. Exclusive Economic Zone are divided into two separate stocks: the Hawaiian stock in Hawaiian waters and the California, Oregon and Washington stock in the Southern California portion of the HSTT Study Area (Carretta et al., 2017c).

3.7.2.3.22.2 Habitat and Geographic Range

In the Pacific, Risso's dolphins are found in the waters around the Hawaiian Islands (Bradford et al., 2017) and off the U.S. West Coast (Barlow, 2016). Studies have documented that 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).

Risso's dolphins had been considered rare in Hawaiian waters (Shallenberger, 1981). However, during a 2002 survey of the Hawaiian Islands U.S. Exclusive Economic Zone, seven sightings were reported; in addition, two sightings were reported from aerial surveys in the Hawaiian Islands (Barlow, 2006; Mobley et al., 2000). During a more recent 2010 systematic survey of the Hawaiian Islands U.S. Exclusive Economic Zone, there were 13 sightings of Risso's dolphins (Bradford et al., 2017). In December–January 2014, using a passive acoustic recording device onboard an unmanned glider south of Oahu, Risso's dolphins were acoustically detected throughout the entire survey except for the southernmost part between Bishop Seamount and McCall Seamount (Klinck et al., 2015). In addition, Risso's dolphins were sighted eight times during Navy monitoring activities within the Hawaii Range Complex between 2005 and 2012 (HDR, 2012). The movements of a single satellite tagged individual ranging broadly over a two-week period between the islands of Hawaii, Kahoolawe, and Lanai (approximately 200 km) suggested it was unlikely there is any resident population for the species in the islands (Baird et al., 2016).

The Risso's dolphin exhibits an apparent seasonal shift in distribution off the U.S. West Coast, with movements from California waters north into Oregon and Washington waters in summer (Carretta et al., 2000; Forney & Barlow, 1998; Green et al., 1992; Soldevilla et al., 2008). During ship surveys conducted quarterly off Southern California from 2004 to 2008, Risso's dolphins were encountered year-round, with highest number of encounter during the cold-water months (Douglas et al., 2014), consistent with previously observed seasonal shifts in distribution (Carretta et al., 2000; Forney & Barlow, 1998; Henderson et al., 2014a; Soldevilla, 2008). Off California, they are commonly seen over the slope and in offshore waters (Barlow & Forney, 2007; Forney et al., 1995; Jefferson et al., 2008b). This species is frequently observed in the waters surrounding San Clemente Island, California (Carretta et al., 2000). Habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. West Coast show that Risso's dolphins exhibit a disjunctive longitudinal distribution, suggesting that there may be two separate populations in this area, although additional genetic data are required for confirmation (Becker et al., 2016). Several stranding records have been documented for this species in central and Southern California between 1977 and 2002 (Zagzebski et al., 2006).

3.7.2.3.22.3 Population Trends

In Hawaii, the broad and overlapping confidence intervals around the two Hawaii survey estimates of abundance preclude any assessment of a trend for this population (Carretta et al., 2015).

For Risso's dolphins in California, Oregon, and Washington waters, differences in estimated abundance between survey years is most likely due to the interannual variability in species distribution rather than a true abundance trend (Carretta et al., 2015). However, based on density estimates derived from aerial survey data collected from 2008 to 2013, the abundance of Risso's dolphin in Southern California waters appears to have increased (Jefferson et al., 2014). Further, examination of sighting and stranding data from the 1950s through 2012 also indicated an increase in the relative occurrence of this species in the Southern California Bight over this time period (Smultea, 2014).

3.7.2.3.22.4 Predator and Prey Interactions

Cephalopods and crustaceans are the primary prey for Risso's dolphins (Clarke, 1996), which feed mainly at night (Baird et al., 2008b; Jefferson et al., 2008b). Research involving 493 stranded and necropsied cetaceans in the Canary Islands found two Risso's dolphins with gas bubble embolisms, which have often been attributed to anthropogenic causes, but with evidence indicating that struggling with a squid during hunting was the most likely cause of those embolisms (Fernandez et al., 2017).

3.7.2.3.22.5 Species-Specific Threats

Risso's dolphins are particularly susceptible to entanglement and fisheries interactions. In Hawaii from 2010 to 2014 there were 21 observed interactions between the longline fishery and Risso's dolphins

(Bradford & Forney, 2017). From 2007 to 2011, there were 4 known Risso's dolphin deaths attributed to human-related causes along the U.S. West Coast (primarily gillnet fishery entanglement) (Carretta et al., 2013b). Seven stranding records exist from the main Hawaiian Islands (Maldini et al., 2005; National Marine Fisheries Service, 2015c). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.23 Dall's Porpoise (*Phocoenoides dalli*)

3.7.2.3.23.1 Status and Management

This species is not listed under the ESA. Dall's porpoise is managed by NMFS in United States Pacific waters as two stocks: (1) a California, Oregon, and Washington stock and (2) an Alaskan stock (Allen & Angliss, 2010; Carretta et al., 2010; Carretta et al., 2017c). The Alaska stock does not occur in the HSTT Study Area.

3.7.2.3.23.2 Habitat and Geographic Range

The Dall's porpoise is one of the most common odontocete species in north Pacific waters (Calambokidis & Barlow, 2004; Ferrero & Walker, 1999; Houck & Jefferson, 1999; Jefferson, 1991; Jefferson et al., 2008b; Williams & Thomas, 2007; Zagzebski et al., 2006). Dall's porpoise is found from northern Baja California, Mexico, north to the northern Bering Sea, and south to southern Japan (Jefferson et al., 1993). However, the species is only common between 32°N and 62°N in the eastern North Pacific (Houck & Jefferson, 1999; Morejohn, 1979). It is typically found in waters at temperatures less than 63°F (17°C) with depths of more than 180 m (Houck & Jefferson, 1999; Reeves et al., 2002b).

Dall's porpoises are not present in the Hawaii portion of the HSTT Study Area.

Dall's porpoise distribution off the U.S. West Coast is highly variable between years, most likely due to changes in oceanographic conditions (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012b; Forney & Barlow, 1998; Forney et al., 2012; Peterson et al., 2006). North-south movements in California, Oregon, and Washington have been observed, with Dall's porpoises shifting their distribution southward during cooler-water periods on both interannual and seasonal time scales (Forney & Barlow, 1998; Peterson et al., 2006). Based on habitat models developed using 1991–2009 survey data collected during summer and fall, Becker et al. (2016) found that encounters of Dall's porpoise increased in shelf and slope waters in the Study Area, and encounters decreased substantially in waters warmer than approximately 63°F (17°C). These patterns are consistent with previous habitat modeling efforts using a subset of the same data (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012b; Becker et al., 2014; Forney et al., 2012; Henderson et al., 2014a).

During ship surveys conducted quarterly off southern California from 2004 to 2008, Dall's porpoise was encountered year-round, with highest encounters during the cold-water months (Douglas et al., 2014; Peterson et al., 2006). There were only five Dall's porpoise sightings during 18 aerial surveys conducted year-round in the Southern California Range Complex from 2008 to 2013 (Jefferson et al., 2014).

3.7.2.3.23.3 Population Trends

No data are available regarding population trends for the stock of Dall's porpoises in California, Oregon and Washington (Carretta et al., 2015). Examination of sighting and stranding data from the 1950s through 2012 suggest that the relative occurrence of this species in the Southern California Bight has not changed substantially over this time period (Smultea, 2014).

3.7.2.3.23.4 Predator and Prey Interactions

The diet of Dall's porpoises, determined from analyses of stomach contents during studies in the north Pacific along the West Coast, included 33 species of near-surface and mid-water fishes, as well as squid (Houck & Jefferson, 1999). Dall's porpoises are known to be preyed on by killer whales and large sharks (Jefferson & Barros, 1997). Attacks by killer whales occur often in Alaskan waters, where they are considered to be a major predator of Dall's porpoise (Jefferson, 2009).

3.7.2.3.23.5 Species-Specific Threats

Dall's porpoises are susceptible to fisheries interactions and entanglement. Mortality occurs as bycatch in a number of United States fisheries, but annual takes are considered small (Carretta et al., 2015). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

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

3.7.2.3.24.1 Status and Management

The Cuvier's beaked whale is not listed under the ESA. Within the HSTT Study Area, Cuvier's beaked whales in Hawaii have been assigned to the Hawaiian stock and in the Southern California portion of the HSTT Study Area, animals are assigned to the California, Oregon, and Washington stock (Carretta et al., 2017c; Carretta et al., 2018a).

3.7.2.3.24.2 Habitat and Geographic Range

Cuvier's beaked whales have an extensive range that includes all oceans, from the tropics to the polar waters of both hemispheres. Cuvier's beaked whales are have been encountered in almost all areas of the Pacific, including the open mid-ocean, wherever surveys have occurred (Hamilton et al., 2009). Cuvier's beaked whales are generally sighted in waters with a bottom depth greater than 200 m and are frequently recorded in waters with bottom depths greater than 1,000 m (Bradford et al., 2013; Falcone et al., 2009; Jefferson et al., 2015). Acoustic sampling of bathymetrically featureless areas off Southern California detected many beaked whales over an abyssal plain, which counters a common misperception that beaked whales are primarily found over slope waters, in deep basins, or over seamounts (Griffiths & Barlow, 2016).

Cuvier's beaked whales are regularly found in waters surrounding the Hawaiian Islands (Baird, 2013a; Baird et al., 2009; Baird et al., 2015d; Barlow, 2006; Baumann-Pickering et al., 2010; Baumann-Pickering et al., 2014; Bradford et al., 2013; Lammers et al., 2015; Mobley, 2004; Oleson et al., 2013; Oleson et al., 2015; Shallenberger, 1981). In Hawaii, Cuvier's beaked whales have been occasionally observed breaching and this along with their large size and visible blows likely increases their detectability (Barlow et al., 2013). During NMFS' 2010 survey of the Hawaiian Islands Exclusive Economic Zone, there were 23 sightings of Cuvier's beaked whales, which were commonly seen nearshore in the Northwestern Hawaiian Islands (Bradford et al., 2013; Oleson et al., 2013; Oleson et al., 2015). Sightings have been reported off the Hawaiian Islands of Lanai, Maui, Hawaii, Niihau, and Kauai, supporting the hypothesis that there is a resident population found in the Hawaiian Islands (Baird, 2013a; Baird et al., 2009; Baird et al., 2015a; Barlow, 2016; Mobley, 2004; Oleson et al., 2013; Oleson et al., 2015; Shallenberger, 1981). Passive acoustic monitoring around the main Hawaiian Islands has routinely recorded the presence of Cuvier's beaked whales (Baumann-Pickering et al., 2010; Lammers et al., 2015). There does not seem to be any association of Cuvier's beaked whales with the presence of seamounts in the Hawaiian Islands. Research by McDonald et al, (2009) did not detect the acoustic presence of Cuvier's beaked whales at Cross Seamount but did detect other beaked whale sounds from an as-yet unidentified type or species; subsequently referred to as a BW38 FM pulse type (Baumann-Pickering et al., 2012; Baumann-Pickering et al., 2014; Baumann-Pickering et al., 2016). These absence of acoustic signals from Cuvier' beaked whales and presence of the BW38 FM pulse type were subsequently verified in the winter of 2014–2015 (December to January) for Cross Seamount and other seamounts to the south of Oahu over the 3-week period of a survey (Klinck et al., 2015). Baumann-Pickering et al. (2016), have suggested a possible opposing pattern of presence, with Cuvier's beaked whales being present when acoustic encounters of BW38 FM pulse type were fewer based on passive acoustic records from a seamount to the west of the Northern Line Islands.

A year-round biologically important small and resident population area has been identified for Cuvier's beaked whales surrounding Hawaii Island, including the Alenuihaha Channel across to Maui (Baird et al., 2015a). A more detailed analysis of the area within the Hawaii Portion of the HSTT Study Area has been presented in Appendix K.

Research involving tagged Cuvier's beaked whales in the Southern California Range Complex (Falcone et al., 2009; Falcone & Schorr, 2011, 2012, 2013, 2014) has documented movements in excess of hundreds of kilometers. Schorr et al. (2014) reported that 5 out of 8 tagged whales journeyed approximately 250 km from their tag deployment location and one of these 5 made an extra-regional excursion over 450 km to the south to Mexico and back. Acoustic data indicates a regional and seasonal (August and September) dip in Cuvier's echolocation clicks during the fall (DiMarzio et al., 2018; Moretti, 2017), which may be tied to some as yet unknown population dynamic or oceanographic and prey availability dynamics (Schorr et al., 2018).

Cuvier's beaked whale is the most commonly encountered beaked whale off the West Coast of the United States (Carretta et al., 2017c). This species is found from Alaska to Baja California, Mexico, and there are no apparent seasonal changes in distribution (Mead, 1989; Pitman et al., 1988). However, Mitchell (1968) reported that strandings from Alaska to Baja California were the most common between February and September. During ship surveys conducted quarterly off southern California from 2004 to 2008, there were only six beaked whale sightings and half of these were Cuvier's beaked whales (Douglas et al., 2014). During 18 aerial surveys conducted in the Southern California Range Complex from 2008 through 2013, Cuvier's beaked whales were sighted on two occasions (Jefferson et al., 2014). Repeated sightings of the same individuals have been reported off San Clemente Island in Southern California, which indicates some level of site fidelity (Falcone et al., 2009; Schorr et al., 2017; Schorr et al., 2018). This species has also frequently been heard on passive acoustic recording devices in the Southern California portion of the Study Area (Griffiths & Barlow, 2016; Širović et al., 2016). In a test of drifting passive acoustic recorders off California in fall 2014, Griffiths and Barlow (2016) reported beaked whale detections over slopes and seamounts, which was not unexpected, and also over deep-ocean abyssal plains, which was a novel finding.

3.7.2.3.24.3 Population Trends

NMFS has determined that, for the Hawaiian Islands, assessment of a population trend will likely require additional survey data and reanalysis of all datasets using comparable methods (Carretta et al., 2017d).

A Bayesian trend analysis of systematic survey data collected from 1991–2008 had suggested a decline in the abundance of beaked whales found in waters off California, Oregon, and Washington (Moore & Barlow, 2013). However, a more recent study (Barlow, 2016) included data from an additional survey conducted in 2014 and indicated that the pattern seen for the U.S. West Coast from 1996 to 2014 may indicate a change in that downward trend. More recently, incorporation of information from the entire 1991 to 2014 time series has suggested an increasing abundance trend and a reversal of the previously indicated declining trend along the U.S. West Coast (Moore & Barlow, 2017). Multiple studies have indicated that, in waters surrounding Navy training and testing areas in Southern California, the abundance of beaked whales remains high, including specifically where Navy has been training and testing for decades. Results from passive acoustic monitoring and other research have estimated regional Cuvier's beaked whale densities that were higher than indicated by NMFS's broad-scale visual surveys for the U.S. West Coast (Debich et al., 2015a; Debich et al., 2015b; Falcone & Schorr, 2012, 2014; Hildebrand et al., 2009; Moretti, 2016; Širović et al., 2016; Smultea, 2014). In a series of surveys from 2006 to 2008, Falcone et al. (2009) proposed that the ocean basin west of San Clemente Island may be an important region for Cuvier's beaked whales. Archived acoustic data gathered over the seven-year interval from 2010 to 2017 found the annual Cuvier's beaked whale abundance for the Navy's range adjacent to San Clemente Islands to have no observed decline and perhaps a slight increase (DiMarzio et al., 2018).

These location-specific results have continuously demonstrated higher abundances observed on the Navy's training and testing areas in Southern California compared to the remainder of the U.S. West Coast. Research also indicates higher than expected residency in the Navy's instrumented Southern California Anti-Submarine Warfare Range in particular (Falcone & Schorr, 2012; Schorr et al., 2018). Photo identification studies in the Southern California Range Complex have identified approximately 100 individual Cuvier's beaked whale individuals, of which as many as 57 percent having been seen in one or more prior years, with re-sightings up to 10 years apart (Falcone & Schorr, 2014; Schorr et al., 2018). The documented residency by many Cuvier's beaked whales over multiple years indicate that a stable population may exist in that small portion of the stock's overall range (Falcone et al., 2009; Falcone & Schorr, 2014; Schorr et al., 2017; Schorr et al., 2018). Resightings of 45 known reproductive females both with and without calves over time have also provided critically needed calving and weaning rate data that will serve as the basis for future population modeling for the species (Schorr et al., 2018).

3.7.2.3.24.4 Predator and Prey Interactions

Cuvier's beaked whales, similar to other beaked whale species, are apparently deepwater feeders (Gassmann et al., 2015; Griffiths & Barlow, 2016). Stomach contents analyses show that they feed mostly on deep-sea squid, fish, and crustaceans (Hickmott, 2005; Santos et al., 2007; West et al., 2017). Documented prey includes a diverse diet represented by at least 45 prey species (West et al., 2017). Feeding may also occur at mid-water, rather than only at or near the bottom, as shown from tagging data on Cuvier's beaked whales (Baird et al., 2005b; Baird et al., 2006d) and from acoustic tracking of their feeding sounds in the Southern California portion of the HSTT Study Area (Gassmann et al., 2015). They apparently use suction to catch and swallow prey (Jefferson et al., 2008b; Werth, 2006a, 2006b). Beaked whales may be preyed upon by killer whales (Heyning & Mead, 2009; Jefferson et al., 2008b; Wellard et al., 2016).

3.7.2.3.24.5 Species-Specific Threats

There were four observed interactions between an unidentified beaked whale and longline fishing activities in Hawaiian waters between 2010 and 2014 (Bradford & Forney, 2016, 2017). The disease morbillivirus has been found in all three known species of beaked whales in Hawaiian waters (Jacob et al., 2016). Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

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

3.7.2.3.25.1 Status and Management

Baird's beaked whale is not listed under the ESA. Baird's beaked whale stocks are defined for the two separate areas within Pacific U.S. waters where they are found: (1) Alaska and (2) California, Oregon, and Washington (Carretta et al., 2010; Carretta et al., 2018a). Baird's beaked whales have a history of commercial harvesting in small numbers by the Russians, Canadians and Americans. The Japanese fishery has historically been responsible for large numbers of deaths (Jefferson et al., 2008b).

3.7.2.3.25.2 Habitat and Geographic Range

Baird's beaked whales are not present in the Hawaii portion of the HSTT Study Area.

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., 2008b; Kasuya, 2009). This species is generally found throughout the colder waters of the North Pacific, ranging from off Baja California, Mexico, to the Aleutian Islands of Alaska (Jefferson et al., 2008b; MacLeod & D'Amico, 2006).

The continental shelf margins from the California coast to 125° West (W) longitude have been identified as key areas for beaked whales (MacLeod & D'Amico, 2006). Baird's beaked whale is found mainly north of 28° N in the eastern Pacific (Kasuya & Miyashita, 1997; Reeves et al., 2003). Along the West Coast, Baird's beaked whales are seen primarily along the continental slope, from late spring to early fall (Carretta et al., 2010; Green et al., 1992; Hamilton et al., 2009). Baird's beaked whales are sighted less frequently and are presumed to be farther offshore during the colder water months of November through April (Carretta et al., 2010). Based on habitat models developed using 1991–2008 survey data collected off the West Coast during summer and fall, Becker et al. (2012b) found that encounters of Baird's beaked whale increased in waters near the 2,000 m isobath. These patterns are consistent with previous habitat modeling efforts using a subset of the same data (Barlow et al., 2009; Forney et al., 2012). During ship surveys conducted quarterly off southern California from 2004 to 2008, there was a single sighting of a group of 20 Baird's beaked whales near the shelf break during a summer survey (Douglas et al., 2014). Baird's beaked whales were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea, 2014).

Although it is unknown if the species migrates, Baird's beaked whales in the western north Pacific are known to move between waters of depths ranging from 1,000 to 3,000 m, where fish that live on or near the bottom of the ocean are abundant (Ohizumi et al., 2003). Similar to the satellite-tag recorded movements of Cuvier's beaked whales over hundreds of miles as noted previously, data from a satellite tagged Baird's beaked whale off Southern California has recently documented movement north along the shelf-edge for more than 400 nautical miles over a 6.5 days for this species of beaked whale as well (Schorr et. al., Unpublished).

3.7.2.3.25.3 Population Trends

A trend-based analysis of line transect surveys conducted off the U.S West Coast between 1991 and 2014 yielded an estimate of abundance of 2,697 (CV=0.60) Baird's beaked whales and an indication that the population has remained stable or increased slightly (Carretta et al., 2017c; Moore & Barlow, 2017).

3.7.2.3.25.4 Predator and Prey Interactions

Baird's beaked whales feed mainly on bottom-dwelling fishes and cephalopods, but occasionally take open ocean fish, such as mackerel, sardine, and saury (Kasuya, 2009; Ohizumi et al., 2003; Walker et al., 2002). Stomach contents from specimens taken in whaling operations off Vancouver Island and off central California included squid, octopus, various species of fishes, and skate egg cases (MacLeod et al., 2003). Baird's beaked whale is known to forage for prey opportunistically at depths of about 1,000 m or more (Ohizumi et al., 2003). This species has been documented to be prey for killer whales and sharks, as evidenced by wounds and scars observed on their bodies (Jefferson et al., 2008b; Kasuya, 2009).

3.7.2.3.25.5 Species-Specific Threats

(Bradford & Forney, 2017)There are no known species-specific threats to Baird's beaked whales in the Study Area. Section 3.7.2.1.5 (General Threats) discusses general threats to marine mammals.

3.7.2.3.26 Blainville's Beaked Whale (*Mesoplodon densirostris*)

3.7.2.3.26.1 Status and Management

Blainville's beaked whale is not listed under the ESA. Due to the difficulty in distinguishing different *Mesoplodon* species from one another at sea during visual surveys, the United States management unit is usually defined to include all *Mesoplodon* species that occur in an area. This is the case in the Southern California portion of the HSTT Study Area where the six species of *Mesoplodon* beaked whales present along the U.S. West Coast is a single stock for all *Mesoplodon* in the California/Oregon/Washington region waters, including Blainville's beaked whale (Carretta et al., 2015; Carretta et al., 2018a). This is not, however, the case for this species in Hawaii. Based on the number of sightings and genetic analysis of individuals around the Hawaiian Islands, NMFS recognizes a Hawaiian stock of Blainville's beaked whale (Carretta et al., 2015; Carretta et al., 2018a; Oleson et al., 2013).

3.7.2.3.26.2 Habitat and Geographic Range

Blainville's beaked whales are one of the most widely distributed of the distinctive toothed whales within the *Mesoplodon* genus (Jefferson et al., 2008b; MacLeod & Mitchell, 2006). They are found mostly offshore in deeper waters along the California coast, Hawaii, Fiji, Japan, and Taiwan, as well as throughout the eastern tropical Pacific (Leslie et al., 2005; MacLeod & Mitchell, 2006; Mead, 1989).

Blainville's beaked whales are regularly sighted in Hawaiian waters (Baird et al., 2003b; Baird et al., 2006d; Baird et al., 2006e; Baird et al., 2015a; Bradford et al., 2017; McSweeney et al., 2007), and their vocalizations have been routinely detected in acoustic monitoring in the Hawaiian Islands (Henderson et al., 2015a; Klinck et al., 2015; Lammers et al., 2015; Manzano-Roth et al., 2016; Manzano-Roth et al., 2013; Rankin & Barlow, 2007). Blainville's beaked whale sounds were detected once at Cross Seamount during a 6-month acoustic monitoring in 2005-2006 (McDonald et al., 2009). In the winter of 2014–2015 during a 3-week period (December to January), Blainville's beaked whale sounds were acoustically detected by an autonomous glider operating in an open ocean area to the south of Oahu and East of Hawaii Island (Klinck et al., 2015). These Blainville's beaked whale sounds were detected along the glider's course both in open ocean areas that lacked significant bathymetric relief and at Brigham Seamount, but not at Cross Seamount or any of the other seamounts areas sampled (Klinck et al., 2015).

Blainville's beaked whale has been detected off the coast of Oahu, Hawaii for prolonged periods annually, and this species is consistently observed in the same site off the West Coast of the Island of Hawaii (Abecassis et al., 2015; Baird et al., 2006d; McSweeney et al., 2007). Thirteen Blainville's beaked whales were satellite tagged off Hawaii Island between 2006 and 2012 with data records ranging from 15 to 159 days (Baird et al., 2011; Baird et al., 2015a). One tagged individual ranged from approximately 18 km to 573 km from land and moved a total of over 900 km from the initial tag location in 20 days. Similar data over an 8-day period for an individual tagged off Kauai showed movement on and off the Navy's instrumented range at Pacific Missile Range Facility three times before transiting to the southwest over a distance of approximately 100 km from the original tag location (Baird et al., 2015b).

The first continuous archive of acoustic data recorded over six months in 2017 at that range was analyzed for Blainville's beaked whale sounds and determined no decline in abundance was indicated (DiMarzio et al., 2018).

Population studies in Hawaii have demonstrated some evidence for residency (McSweeney et al., 2007). A year-round biologically important small and resident population area has been identified for Blainville's beaked whales off the West Coast and North Kohala portion of the Island of Hawaii (Baird et al., 2015a). The area forms a rough polygon around satellite tag locations for 10 whales in the area from 2009-2011 (Baird et al., 2015a). A more detailed analysis of the area within the Hawaii Portion of the HSTT Study Area has been presented in Appendix K (Geographic Mitigation Assessment). Although there is currently a single stock of Blainville's beaked whales in Hawaii, NMFS has indicated that division of this population into a separate island-associated stock may be warranted in the future (Carretta et al., 2017d); presumably along with the remainder designated a pelagic stock or something similar.

There are a handful of known records of Blainville's beaked whale from the coast of California and Baja California, Mexico, but the species does not appear to be common in the Southern California portion of the Study Area (Hamilton et al., 2009; Mead, 1989; Pitman et al., 1988). *Mesoplodon* beaked whales were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea, 2014).

3.7.2.3.26.3 Population Trends

For the Hawaiian Islands, the currently available data precludes evaluation of population trends for Blainville's beaked whales in the Hawaiian stock (Carretta et al., 2017c; Carretta et al., 2017d). Acoustic monitoring using the Navy range hydrophones off Kauai from 2010 to 2014 suggest a low but stable abundance of *Mesoplodon* beaked whales at that location (DiMarzio et al., 2018; Moretti, 2016).

A Bayesian trend analysis of systematic survey data collected from 1991–2008 suggested a decline in the abundance of beaked whales found in waters off California, Oregon, and Washington (Moore & Barlow, 2013). However, a more recent survey in 2014 (Barlow, 2016), and a new analysis incorporating information from all surveys between 1991 and 2014, suggests an increasing abundance for the U.S. West Coast trend over that time, which is a reversal of the previously reported population decline (Carretta et al., 2017d; Moore & Barlow, 2017).

3.7.2.3.26.4 Predator and Prey Interactions

All beaked whales probably feed at or close to the bottom in deep oceanic waters, taking suitable prey opportunistically or as locally abundant, typically by suction feeding (Heyning & Mead, 1996; Jefferson et al., 2015; MacLeod et al., 2003; Werth, 2006a, 2006b). Feeding may also occur at mid-water, rather than only at or near the bottom, as shown from tagging data from Blainville's beaked whales (Baird et al., 2005a; Baird et al., 2006e). Blainville's beaked whales are known to echolocate in groups when they are on foraging dives which makes them more easily detectable by passive acoustic means (Moretti & Baird, 2015). *Mesoplodon* beaked whales have been observed being actively preyed upon by killer whales (Wellard et al., 2016).

3.7.2.3.26.5 Species-Specific Threats

There were five observed interactions between an unidentified beaked whale, unidentified *Mesoplodont* beaked whale, or Blainville's beaked whale and longline fishing activities based in Hawaii between 2010 and 2014 (Bradford & Forney, 2016, 2017). There were two strandings of Blainville's beaked whales between 2010 and 2014 (National Marine Fisheries Service, 2015c). The individual that stranded in 2011 tested positive for morbillivirus (Jacob et al., 2016).

3.7.2.3.27 Longman's Beaked Whale (*Indopacetus pacificus*)

3.7.2.3.27.1 Status and Management

Longman's beaked whale is not listed under the ESA. A Hawaiian stock, consisting of those individuals present within the EEZ around Hawaii, is the only stock identified in the Pacific Stock Assessment Report (Carretta et al., 2017c; Carretta et al., 2017d; Carretta et al., 2018a).

3.7.2.3.27.2 Habitat and Geographic Range

Longman's beaked whale is found in warm tropical waters, with most sightings occurring in waters with sea surface temperatures warmer than 78 °F (26°C) (Anderson et al., 2006; MacLeod et al., 2006; MacLeod & D'Amico, 2006). Although the full extent of this species' distribution is not fully understood, there have been many recorded sightings at various locations in tropical waters of the Pacific and Indian Oceans (Afsal et al., 2009; Dalebout et al., 2002; Dalebout et al., 2003; Moore, 1972). Sighting records of this species in the Indian Ocean showed that Longman's beaked whales are typically found in waters over deep bathymetric slopes of 200 to 2,000+ m (Anderson et al., 2006). In the Pacific, records of this species indicate presence in the eastern, central, and western Pacific, including waters off the coast of Mexico.

Based on systematic survey data collected from 1986-2005 in the eastern Pacific, all Longman's beaked whale sightings were south of 25° N (Hamilton et al., 2009).

There was a single sighting of approximately 18 Longman's beaked whales during the 2002 Hawaiian Islands Cetacean and Ecosystem Assessment survey (Barlow, 2006). During the follow-on 2010 survey, there were three sightings of Longman's beaked whales, with group sizes ranging from approximately 32 to 99 individuals (Bradford et al., 2017). Longman's beaked whales have also been sighted off Kona (Cascadia Research, 2012) and there have been two known strandings of this species in the main Hawaiian Islands (Maldini et al., 2005; National Marine Fisheries Service, 2015c; West et al., 2012).

Longman's beaked whales are not present in the Southern California portion of the HSTT Study Area.

3.7.2.3.27.3 Population Trends

NMFS has determined that assessment of a population trend for Longman's beaked whales will likely require additional survey data and reanalysis of all datasets using comparable methods (Carretta et al., 2017d).

3.7.2.3.27.4 Predator and Prey Interactions

All beaked whales probably feed at or close to the bottom in deep oceanic waters, taking suitable prey opportunistically or as locally abundant, typically by suction feeding (Heyning, 1989; Heyning & Mead, 1996; MacLeod et al., 2003). Feeding may also occur at mid-water, rather than only at or near the bottom, as shown from tagging data on Cuvier's and Blainville's beaked whales (Baird et al., 2005b; Baird et al., 2006e). This may also be the case with Longman's beaked whales. *Mesoplodon* beaked whales have been observed being actively preyed upon by killer whales (Wellard et al., 2016) so this may be the case for Longman's beaked whales as well.

3.7.2.3.27.5 Species-Specific Threats

Little information exists regarding species-specific threats to Longman's beaked whales in the HSTT Study Area. There have been two known strandings of this species in the main Hawaiian Islands (Maldini et al., 2005; National Marine Fisheries Service, 2015c; West et al., 2012). Morbillivirus in the central Pacific was present in a juvenile male Longman's beaked whale that stranded on Maui in 2010 (Jacob et al., 2016; West et al., 2012) and was present in a stranding in New Caledonia involving five individuals (Garrigue et al., 2016). There were two observed interactions between an unidentified beaked whales and longline fishing activities in Hawaiian waters between 2009 and 2013 (Bradford & Forney, 2016).

3.7.2.3.28 Ginkgo-toothed Beaked Whale (*Mesoplodon ginkgodens*)

3.7.2.3.28.1 Status and Management

The ginkgo-toothed beaked whale is not listed under the ESA. Due to the difficulty in distinguishing the different *Mesoplodon* species from one another at sea during visual surveys, the United States management unit is defined to include all *Mesoplodon* species that occur in the area (Carretta et al., 2015; Jefferson et al., 2008b). The ginkgo-toothed beaked whale has been combined with five other *Mesoplodon* species to make up the California, Oregon, and Washington stock (Carretta et al., 2015; Carretta et al., 2018a).

3.7.2.3.28.2 Habitat and Geographic Range

Worldwide, beaked whales normally inhabit continental slope and deep ocean waters (greater than 200 m) and are only occasionally reported in waters over the continental shelf (Cañadas et al., 2002; Ferguson et al., 2006; MacLeod & Mitchell, 2006; Pitman, 2009; Waring et al., 2001).

Assuming that the ginkgo-toothed beaked whale distribution is continuous across the north Pacific, this species could be found in waters off Hawaii; however, no strandings, captures, or sightings have been recorded for this species in Hawaiian waters (MacLeod & D'Amico, 2006). Baumann-Pickering et al. (2012) hypothesize that an unknown likely beaked whale acoustic signal detected at Cross Seamount in Hawaii was likely produced by a ginkgo-toothed beaked whale, although there has been no visual confirmation of the species' presence in Hawaiian waters (Baumann-Pickering et al., 2012; Baumann-Pickering et al., 2014; Baumann-Pickering et al., 2016; Klinck et al., 2015). NMFS does not currently recognize the ginkgo-toothed beaked whale as being present in Hawaiian waters (Carretta et al., 2017c; Carretta et al., 2018a).

The distribution of the ginkgo-toothed beaked whale likely includes deep waters off the Pacific coast of North America. The handful of known records of the ginkgo-toothed beaked whale are from strandings, one of which occurred in California (Jefferson et al., 2015; MacLeod & D'Amico, 2006). *Mesoplodon* beaked whales were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea, 2014).

3.7.2.3.28.3 Population Trends

A Bayesian trend analysis of systematic survey data collected from 1991-2008 had previously suggested a decline in the abundance of beaked whales found in waters off California, Oregon, and Washington (Moore & Barlow, 2013). However, a more recent survey in 2014 (Barlow, 2016), and a new analysis incorporating information from all surveys between 1991 and 2014, suggests an increasing abundance for the U.S. West Coast trend over that time, which is a reversal of the previously reported population decline (Carretta et al., 2017d; Moore & Barlow, 2017).

3.7.2.3.28.4 Predator and Prey Interactions

All beaked whales probably feed at or close to the bottom in deep oceanic waters, taking suitable prey opportunistically or as locally abundant, typically by suction feeding (Heyning, 1989; Heyning & Mead, 1996; MacLeod et al., 2003). Feeding may also occur at mid-water, rather than only at or near the bottom, as shown from tagging data on Cuvier's and Blainville's beaked whales (Baird et al., 2005b; Baird et al., 2006e). This may also be the case with ginkgo-toothed beaked whales. Although published analyses of stomach contents from ginkgo-toothed beaked whales are not available, this species presumably preys on squid and possibly fish, similar to other *Mesoplodon* species. These species occupy an ecological niche distinct from Cuvier's beaked whales by feeding on smaller squids, allowing the different beaked whale species to coexist (MacLeod et al., 2003; MacLeod, 2005). *Mesoplodon* beaked whales have been observed being actively preyed upon by killer whales (Wellard et al., 2016).

3.7.2.3.28.5 Species-Specific Threats

No information exists regarding species-specific threats to ginkgo-toothed beaked whales in the Study Area.

3.7.2.3.29 Perrin's Beaked Whale (*Mesoplodon perrini*)

3.7.2.3.29.1 Status and Management

Perrin's beaked whale was described as a new species of marine mammal in 2002 (Dalebout et al., 2002).Perrin's beaked whale is not listed under the ESA. Due to the difficulty in distinguishing the *Mesoplodon* species at sea during visual surveys, the management unit has been defined by NMFS to include all *Mesoplodon* species that occur in the area. Perrin's beaked whale has been combined with other *Mesoplodon* species to make up the California, Oregon, and Washington stock (Carretta et al., 2017c; Carretta et al., 2018a).

3.7.2.3.29.2 Habitat and Geographic Range

Worldwide, beaked whales normally inhabit continental slope and deep oceanic waters (greater than 200 m) and are only occasionally reported in waters over the continental shelf (Cañadas et al., 2002; Ferguson et al., 2006; MacLeod & Mitchell, 2006; Pitman, 2009; Waring et al., 2001).

Perrin's beaked whales are not present in the Hawaii portion of the HSTT Study Area.

Perrin's beaked whale is known only from five strandings along the California coastline from 1975 to 1997 (Dalebout et al., 2002; MacLeod & Mitchell, 2006). These strandings include two at U.S. Marine Corps Base Camp Pendleton (33°15' N, 117°26' W), and one each at Carlsbad, (33°07' N, 117°20' W), Torrey Pines State Reserve (32°55' N, 117°15' W), and Monterey (36°37' N, 121°55' W) (Dalebout et al., 2002; Mead, 1981). These stranded animals were previously identified as Hector's beaked whale but have been reclassified as Perrin's beaked whale (Dalebout et al., 2002; Mead, 1981; Mead & Baker, 1987; Mead, 1989). While this stranding pattern suggests an eastern North Pacific Ocean distribution, too few records exist for this to be conclusive (Dalebout et al., 2002). Due to the scarcity of data, the full extent of Perrin's beaked whale distribution is unknown; however, it likely occurs primarily in oceanic waters of the eastern north Pacific with depths exceeding 1,000 m (MacLeod & Mitchell, 2006). *Mesoplodon* beaked whales were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea, 2014). Acoustic monitoring from devices located at seven sites in the Southern California Bight (across a broad area stretching of from Santa Cruz Island to an open ocean area south of San Clemente Island) documented the presence of a beaked whale-like frequency-modulated pulse type that may possibly be produced by Perrin's beaked whale since it is otherwise unidentified (Baumann-Pickering et al., 2014; Baumann-Pickering et al., 2015; Debich et al., 2015b).

3.7.2.3.29.3 Population Trends

A Bayesian trend analysis of systematic survey data collected from 1991-2008 suggested a decline in the abundance of beaked whales found in waters off California, Oregon, and Washington (Moore & Barlow, 2013). However, a more recent survey in 2014 (Barlow, 2016), and a new analysis incorporating information from all surveys between 1991 and 2014, suggests an increasing abundance for the U.S. West Coast trend over that time, which is a reversal of the previously reported population decline (Carretta et al., 2017d; Moore & Barlow, 2017).

3.7.2.3.29.4 Predator and Prey Interactions

All beaked whales probably feed at or close to the bottom in deep oceanic waters taking suitable prey opportunistically or as locally abundant (Heyning, 1989; Heyning & Mead, 1996; MacLeod et al., 2003). Feeding may also occur at mid-water rather than only at or near the bottom, as shown from recent tagging data on Cuvier's and Blainville's beaked whales (Baird et al., 2004). This may also be the case with this species. Stomach contents analyses of captured and stranded individuals suggest beaked whales are deep divers that feed by suction on mid-water fishes, squids, and deepwater bottom-feeding invertebrates (Heyning, 1989; Heyning & Mead, 1996; MacLeod et al., 2003; Santos et al., 2001; Santos et al., 2007). Dalebout et al. (2002) reported finding deep-sea squid species within stomach contents of stranded Perrin's beaked whales. *Mesoplodon* species occupy an ecological niche distinct from Cuvier's beaked whales by feeding on smaller squids, allowing the different beaked whale species to coexist (MacLeod et al., 2003; MacLeod, 2005). *Mesoplodon* beaked whales have been observed being actively preyed upon by killer whales (Wellard et al., 2016).

3.7.2.3.29.5 Species-Specific Threats

No information exists regarding species-specific threats to Perrin's beaked whales in the Study Area.

3.7.2.3.30 Stejneger's Beaked Whale (*Mesoplodon stejnegeri*)

Stejneger's beaked whale was initially described in 1885 from a skull, and nothing more of the species was known for nearly a century. The late 1970s saw several strandings, but it was not until 1994 that the external appearance was well described from fresh (stranded) specimens.

3.7.2.3.30.1 Status and Management

Stejneger's beaked whale is not listed under the ESA. Due to the difficulty in distinguishing the *Mesoplodon* species at sea during visual surveys, the United States management unit is defined to include all *Mesoplodon* species that occur in the area. Stejneger's beaked whale has been combined with five other *Mesoplodon* species to make up the California, Oregon, and Washington stock (Carretta et al., 2015; Carretta et al., 2018a).

3.7.2.3.30.2 Habitat and Geographic Range

Worldwide, beaked whales normally inhabit continental slope and deep oceanic waters (greater than 200 m) (Cañadas et al., 2002; Ferguson et al., 2006; MacLeod & Mitchell, 2006; Pitman, 2009; Waring et al., 2001). They are occasionally reported in waters over the continental shelf (Pitman & Stinchcomb, 2002).

Stejneger's beaked whales are not present in the Hawaii portion of the HSTT Study Area.

Stejneger's beaked whale appears to prefer cold to temperate and subpolar waters (MacLeod & Mitchell, 2006). This species has been observed in waters ranging from 730 to 1,560 m deep on the steep slope of the continental shelf (Loughlin & Perez, 1985). The southern limit in the central Pacific is unknown but is likely to range between 60° N and 30° N (Baumann-Pickering et al., 2014; Loughlin & Perez, 1985; MacLeod & Mitchell, 2006). Specific movement patterns of this species are not known, but high stranding rates in the winter and spring along the Pacific coast suggest that Stejneger's beaked whales migrate north during summer (Jefferson et al., 2008b; Pitman, 2009). Stejneger's beaked whales are not considered to regularly occur in Southern California coastal waters (Jefferson et al., 2008b; MacLeod & Mitchell, 2006). The farthest south this species has been observed in the eastern Pacific is Cardiff, California (33° N), but this is considered an extralimital occurrence (Loughlin & Perez, 1985; MacLeod & Mitchell, 2006; Mead, 1989). *Mesoplodon* beaked whales were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea, 2014). Beaked whales produce species-specific frequency modulated echolocation pulses. Acoustic monitoring at a site (Site "M") located at the northern edge of the Southern California portion of the HSTT Study Area recorded the presence of sounds from Stejenger's beaked whales once in July 2009 and again in July 2010 (Baumann-Pickering et al., 2014).

3.7.2.3.30.3 Population Trends

A Bayesian trend analysis of systematic survey data collected from 1991-2008 suggested a decline in the abundance of beaked whales found in waters off California, Oregon, and Washington (Moore & Barlow, 2013). However, a more recent survey in 2014 (Barlow, 2016), and a new analysis incorporating information from all surveys between 1991 and 2014, suggests an increasing abundance for the U.S. West Coast trend over that time, which is a reversal of the previously reported population decline (Carretta et al., 2017d; Moore & Barlow, 2017).

3.7.2.3.30.4 Predator and Prey Interactions

Stejneger's beaked whales are known to feed primarily on squids of the families Gonatidae and Cranchiidae, typically in mid-water to near-bottom depths. Analyses of stomach contents of this species found they also feed on deep-sea fish (Jefferson et al., 2008b; Walker & Hanson, 1999; Yamada, 1998). This species has not been documented to be prey to any other species, though other *Mesoplodon* beaked whales have been observed being actively preyed upon by killer whales (Wellard et al., 2016).

3.7.2.3.30.5 Species-Specific Threats

There are no known specific threats to this species.

3.7.2.3.31 Hubbs' Beaked Whale (*Mesoplodon carlhubbsi*)

3.7.2.3.31.1 Status and Management

Hubbs' beaked whale is not listed under the ESA. Due to the difficulty in distinguishing the different *Mesoplodon* species from one another at sea during visual surveys, the United States management unit is defined to include all *Mesoplodon* species that occur in the area. Hubbs' beaked whale has been combined with five other *Mesoplodon* species to make up the California, Oregon, and Washington stock (Carretta et al., 2015; Carretta et al., 2018a).

3.7.2.3.31.2 Habitat and Geographic Range

The distribution of Hubbs' beaked whale is generally associated with the deep subarctic current system along the Pacific coast of North America (Mead et al., 1982; Mead, 1989). MacLeod et al. (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. The beaked whale-like frequency modulated pulse type ("BW40") recorded off Pearl and Hermes Reef (in the Northwest Hawaiian Islands) and Wake Atoll may possibly be produced by Hubbs' beaked whale (Baumann-Pickering et al., 2014).

Assuming that Hubbs' beaked whale distribution is continuous across the north Pacific, they could be found in waters off Hawaii; however, no strandings or sightings have been recorded for this species in Hawaiian waters (MacLeod & Mitchell, 2006; Mead, 1989). NMFS does not recognize this species as a stock in the Hawaii portion of the HSTT Study Area.

Mead (1989) speculated that the range of Hubbs' beaked whale includes the northernmost portion of the Study Area off California. During systematic surveys conducted from 1986 to 2005 in the eastern Pacific, there was one confirmed sighting of Hubbs' beaked whale in offshore waters off the state of Washington (Hamilton et al., 2009). *Mesoplodon* beaked whales were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea, 2014). The beaked whale-like frequency modulated pulse type ("BW40") recorded off Southern California may possibly be produced by Hubbs' beaked whale (Baumann-Pickering et al., 2014; Debich et al., 2015b).

3.7.2.3.31.3 Population Trends

A Bayesian trend analysis of systematic survey data collected from 1991 to 2008 suggested a decline in the abundance of beaked whales found in waters off California, Oregon, and Washington (Moore & Barlow, 2013). However, a more recent survey in 2014 (Barlow, 2016), and a new analysis incorporating information from all surveys between 1991 and 2014, suggests an increasing abundance for the U.S. West Coast trend over that time, which is a reversal of the previously reported population decline (Carretta et al., 2017d; Moore & Barlow, 2017).

3.7.2.3.31.4 Predator and Prey Interactions

All beaked whales probably feed at or close to the bottom in deep oceanic waters (Heyning, 1989; Heyning & Mead, 1996; MacLeod et al., 2003). Feeding may also occur at mid-water, rather than only at or near the bottom, as shown from tagging data on Cuvier's and Blainville's beaked whales (Baird et al., 2004). This may also be the case with this species. Stomach contents analyses of Hubbs' beaked whales indicated squid beaks, fish ear bones, and other fish bones (MacLeod et al., 2003; Mead et al., 1982). *Mesoplodon* species occupy an ecological niche distinct from that of Cuvier's beaked whales by feeding on smaller squids, allowing the different beaked whale species to coexist (MacLeod et al., 2003; MacLeod, 2005). *Mesoplodon* beaked whales have been observed being actively preyed upon by killer whales (Wellard et al., 2016).

3.7.2.3.31.5 Species-Specific Threats

There are no known threats specific to this species.

3.7.2.3.32 Pygmy Beaked Whale (*Mesoplodon peruvianus*)

Literature published before the pygmy beaked whale was identified referred to it by the common name "*Mesoplodon* species A" (Pitman & Lynn, 2001). It is also commonly referred to as "Lesser beaked whale" (Carretta et al., 2015). The pygmy beaked whale was first described as a new species in 1991 (Jefferson et al., 2008b).

3.7.2.3.32.1 Status and Management

The pygmy beaked whale is not listed under the ESA. Due to the difficulty in distinguishing the *Mesoplodon* species at sea during visual surveys, the United States management unit is defined to include all *Mesoplodon* species that occur in the area. The pygmy beaked whale has been combined with five other *Mesoplodon* species to make up the California, Oregon, and Washington stock (Carretta et al., 2010; Carretta et al., 2018a).

3.7.2.3.32.2 Habitat and Geographic Range

Worldwide, beaked whales normally inhabit continental slope and deep oceanic waters (greater than 200 m) and are only occasionally reported in waters over the continental shelf (Cañadas et al., 2002; Ferguson et al., 2006; MacLeod & Mitchell, 2006; Pitman, 2009; Waring et al., 2001). Based on stranding data from the Pacific coast of Bahia de La Paz, Mexico, this species' range is thought to include deep waters off the Pacific coast of North America (Aurioles-Gamboa & Urban-Ramirez, 1993; Jefferson et al., 2008b; Urban-Ramirez & Aurioles-Gamboa, 1992). This species was first described in 1991 from stranded specimens from Peru, and since then, strandings have been recorded along the coasts of Mexico, Peru, and Chile (Pitman & Lynn, 2001; Reyes et al., 1991; Sanino et al., 2007). Based on sightings and strandings, the pygmy beaked whale is presumed to be found only in the eastern tropical Pacific. MacLeod et al. (2006) suggested that the pygmy beaked whale occurs in the eastern Pacific from about 30° N to about 30° South (S).

There have been no strandings or sightings of pygmy beaked whales in Hawaiian waters (MacLeod & Mitchell, 2006; Mead, 1989); pygmy beaked whales are not expected to be present in the Hawaii portion of the HSTT Study Area.

Pygmy beaked whales are assumed to be present in the Southern California portion of the HSTT Study Area. *Mesoplodon* beaked whales were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea, 2014). Acoustic monitoring has documented the presence of a beaked whale-like frequency modulated pulse type ("BW70") in Southern California that may possibly be produced by pygmy beaked whales (Baumann-Pickering et al., 2014).

3.7.2.3.32.3 Population Trends

A Bayesian trend analysis of systematic survey data collected from 1991–2008 suggested a decline in the abundance of beaked whales found in waters off California, Oregon, and Washington (Moore & Barlow, 2013). However, a more recent survey in 2014 (Barlow, 2016), and a new analysis incorporating information from all surveys between 1991 and 2014, suggests an increasing abundance for the U.S. West Coast trend over that time, which is a reversal of the previously reported population decline (Carretta et al., 2017d; Moore & Barlow, 2017).

3.7.2.3.32.4 Predator and Prey Interactions

All beaked whales probably feed at or close to the bottom in deep oceanic waters taking suitable prey opportunistically or as locally abundant (Heyning, 1989; Heyning & Mead, 1996; MacLeod et al., 2003). Feeding may also occur at mid-water, rather than only at or near the bottom, as shown from recent tagging data on Cuvier's and Blainville's beaked whales (Baird et al., 2004). This may also be the case with this species. Stomach contents analyses are available for only two pygmy beaked whales; the contents included no squid beaks but did include ear bones of perches and ray-finned fish (Reyes et al., 1991). *Mesoplodon* species occupy an ecological niche distinct from Cuvier's beaked whales by feeding on smaller squids, allowing the different beaked whale species to coexist. The stomach contents of this species suggests even less overlap with the Cuvier's beaked whale (MacLeod et al., 2003; MacLeod, 2005). *Mesoplodon* beaked whales have been observed being actively preyed upon by killer whales (Wellard et al., 2016).

3.7.2.3.32.5 Species-Specific Threats

There are no known species-specific threats to pygmy beaked whales in the Study Area.

3.7.2.3.33 California Sea Lion (*Zalophus californianus*)

3.7.2.3.33.1 Status and Management

The California sea lion is not listed under the ESA. The California sea lion is managed by NMFS as the designated U.S. Stock (Carretta et al., 2017c).

3.7.2.3.33.2 Habitat and Geographic Range

California sea lions are not present in Hawaii. The California sea lion occurs in the eastern north Pacific from Puerto Vallarta, Mexico, through the Gulf of California and north along the West Coast of North America to the Gulf of Alaska (Barlow et al., 2008; Jefferson et al., 2008b; Maniscalco et al., 2004). Typically, during the summer, California sea lions congregate near rookery islands and specific open-water areas. The primary rookeries off the coast of the United States are on San Nicolas, San Miguel, Santa Barbara, and San Clemente Islands (Carretta et al., 2000; Le Boeuf & Bonnell, 1980; Lowry et al., 1992; Lowry & Forney, 2005; Lowry et al., 2017). Haulout sites are also found on Santa Catalina Island in the Southern California Bight (Le Boeuf, 2002). This species is prone to invade human-modified coastal sites that provide good haulout substrate, such as marinas, buoys, bait barges, and rip-rap tidal control structures.

California sea lions are the most common marine mammal in San Diego Bay based on monitoring and survey results (Graham & Saunders, 2015; U.S. Department of the Navy, 2015b). There are two "bait" barges near the mouth of San Diego Bay that are resting locations for California sea lions (U.S. Department of the Navy, 2015b). Monitoring (October 2014 to April 2015) during a pier replacement project at Point Loma found the number of California sea lions averaged approximately 38 sea lions hauled out and 2 to 3 individuals in the water (U.S. Department of the Navy, 2015b).

In the nonbreeding season, beginning in late-summer, adult and subadult males migrate northward along the coast of California to Washington and return south the following spring (Laake, 2017; Lowry & Forney, 2005). Females and juveniles also disperse somewhat, but tend to stay in the Southern California area, although north and west of the Channel Islands (Lowry & Forney, 2005; Melin & DeLong, 2000; Thomas et al., 2010). California sea lions from the West Coast of the Baja California peninsula also migrate to Southern California during the fall and winter (Lowry & Forney, 2005) and sea lions from San Clemente Island tend to remain in Southern California (Melin, 2015). There is a general distribution shift northwest in fall and southeast during winter and spring, probably in response to changes in prey availability (Carretta et al., 2010).

California sea lions can be found in California open ocean and coastal waters (Barlow et al., 2008; Jefferson et al., 2008b; Lander et al., 2010). California sea lions are usually found in waters over the continental shelf and slope; however, they are also known to occupy locations far offshore in deep, oceanic waters, such as Guadalupe Island, Alijos Rocks off Baja California (Jefferson et al., 2008b; Melin et al., 2008; Urrutia & Dziendzielewski, 2012; Zavala-Gonzalez & Mellink, 2000). California sea lions are the most frequently sighted pinnipeds offshore of Southern California during the spring, and peak abundance is during the May through August breeding season (Green et al., 1992; Keiper et al., 2005; Lowry et al., 2017).

Tagged California sea lions from Monterey Bay and San Nicolas Island, California, demonstrated that adult males can travel more than 450 km from shore during longer foraging bouts (Weise et al., 2006; Weise et al., 2010); however, rehabilitated females and subadults normally stay within 65 km of the coast (Thomas et al., 2010). Most individuals stay within 50 km of the rookery islands during the breeding season (Melin & DeLong, 2000). Females breeding and pupping on the Channel Islands typically feed over the continental shelf and generally remain within 150 km north and west of the islands (Kuhn & Costa, 2014; Melin & DeLong, 2000; Melin et al., 2008; Melin et al., 2012). Tagging results showed that lactating females foraging along the coast would travel as far north as Monterey Bay and offshore to the 1,000 m isobath (Henkel & Harvey, 2008; Kuhn & Costa, 2014; Melin & DeLong, 2000; Melin et al., 2008). During the nonbreeding season, they occur most often over the slope or offshore; during the breeding season, they occur most often over the continental shelf (Melin & DeLong, 2000; Melin et al., 2008). Lowry and Forney (2005) estimated that 47 percent of sea lions would potentially be at-sea during the cold seasons.

Dive durations range from 1.4–5.0 minutes with longer dives during El Niño events; surface intervals range from 0.7-17.0 minutes with sea lions diving about 32-47 percent of the time at sea (Feldkamp et al., 1989; Kuhn & Costa, 2014; Melin et al., 2008; Melin et al., 2012). Adult females alternate between nursing their pup on shore and foraging at sea, spending approximately 67-77 percent of time at sea (Kuhn & Costa, 2014; Melin & DeLong, 2000).

3.7.2.3.33.3 Population Trends

The California sea lion is the most abundant pinniped along the California coast. Overall, the California sea lion population is abundant and generally increasing (Carretta et al., 2010; Jefferson et al., 2008b).

In spite of the robustness of the overall species population, in Mexican waters in the Gulf of California, the abundance of California sea lions has declined over the last decade (Urrutia & Dziendzielewski, 2012). A time-series data analysis supported the hypothesis that the Gulf of California has four subpopulations of California sea lions, most of which exhibit lower-than-expected growth rates and two of which have high probabilities of extinction within the next 50 years (Ward et al., 2010).

Using count and resighting data gathered between 1975 to 2015, NMFS researchers showed that California sea lion population growth was above the maximum net productivity level and within the range of the optimal sustainable population (Laake et al., 2018). This research also noted that the species abundance can be dramatically decreased by increasing sea surface temperature associated with El Nino events or similar regional ocean temperature anomalies (Laake et al., 2018).

3.7.2.3.33.4 Predator and Prey Interactions

California sea lions are known to feed in both benthic and open-water habitats, which allows for a broader feeding spectrum than other pinnipeds that have overlapping foraging areas (e.g., Guadalupe fur seal). The California sea lion is adapted to cope with changes in prey availability (Aurioles-Gamboa & Camacho-Rios, 2007). California sea lions feed on a variety of fish and cephalopod species, including salmon, Pacific sardines, northern anchovy, Pacific mackerel, Pacific whiting, rockfish, market squid, bass, cutlassfish, cusk eels, greenlings, dogfish, perch, various flatfish, and various species of midshipmen and lanternfish (Lowry & Forney, 2005; Orr et al., 2011; Orr et al., 2012). California sea lions have been documented to be preyed on by killer whales, sharks, coyotes, and feral dogs. In the California Channel Islands, California sea lion pups were at one time observed being preyed on by bald eagles (Heath & Perrin, 2009).

3.7.2.3.33.5 Species-Specific Threats

California sea lions are susceptible to entanglement and other interactions with fishery operations. Carretta et al. (2013b) report 334 deaths and 469 serious injuries to California sea lions along the U.S. West Coast from 2007 to 2011 due to human-related causes (primarily hook and line fishery entanglement). From a total of 7,673 California sea lions reported as stranded along the central

California coast between 2003 and 2015, 277 were determined to be caused by entanglement in marine debris, 35 by gunshots, and 158 by fishing tackle injuries (Barcenas De La Cruz et al., 2017).

Along California's coast mortality has been documented due to domoic acid toxicity, which is a neurotoxin associated with algal blooms which may be exacerbated by the recent increase in water temperature in the northeastern Pacific (Bond et al., 2015). The toxoplasmosis parasite (often attributed to feral cat feces in urban area storm run-off) also impacts sea lions (Simeone et al., 2015).

Starting in January 2013, an elevated number of strandings of California sea lion pups were observed in five Southern California counties, including San Diego County, which is part of the Study Area. These strandings were declared an Unusual Mortality Event by NMFS. This is the sixth Unusual Mortality Event involving California sea lions that has occurred in California since 1991. The 2013 Unusual Mortality Event had been confined to California sea lion pups born in the summer of 2012, but as of 2016 had affected other pinniped species in the area (National Marine Fisheries Service, 2015e; National Oceanic and Atmospheric Administration, 2018a, 2018b). The stranded pups were found to be emaciated, dehydrated, and underweight for their age. Although the exact causes of this Unusual Mortality Event are unknown, the working hypotheses are that a shift in the sea lion prey may have resulted in these young animals being abandoned by their mothers, nutritional stress of pups resulting from a lack of forage fish available to lactating mothers, and unknown disease agents (Carretta et al., 2017c; National Oceanic and Atmospheric Administration, 2018a). Surveys in 2016 at San Nicolas Island and San Miguel Island found better growth and body condition for sea lions at both locations than had been present in recent years (Laake, 2017). The average January–June stranding rate in 2017 was below the average stranding rate for the years 2003–2012 (National Oceanic and Atmospheric Administration, 2018a), which may also suggest this mortality event has ended.

3.7.2.3.34 Northern Fur Seal (*Callorhinus ursinus*)

3.7.2.3.34.1 Status and Management

Two stocks of northern fur seals are recognized in United States waters: an eastern Pacific stock and a California stock (Carretta et al., 2017c). The California stock, which is present in the Southern California portion of the HSTT Study Area, is not considered depleted and is not listed under the ESA (Carretta et al., 2017c).

3.7.2.3.34.2 Habitat and Geographic Range

Northern fur seals range throughout the north Pacific along the West Coast, from California (32° N) to the Bering Sea, and west to the Sea of Okhotsk and Honshu Island, Japan (36° N) (Baird & Hanson, 1997; Carretta et al., 2010; Gentry, 2009; Jefferson et al., 2008b; Ream et al., 2005). They are typically found over the edge of the continental shelf and slope (Gentry, 2009; Sterling & Ream, 2004), although two fur seals were tracked over 2,000 km offshore into the central North Pacific Ocean (Ream et al., 2005). Northern fur seals are found throughout their offshore range throughout the year, although seasonal peaks are known to occur. Females and subadult males are often observed off Canada's West Coast during winter (Baird & Hanson, 1997).

Northern fur seals do not normally occur in Hawaiian waters. In July 2012, an adult female northern fur seal was found on the north shore of Oahu in an emaciated condition (Marine Mammal Center, 2012). This was the first known occurrence of a northern fur seal in Hawaii and they are considered extralimital to those waters.

To the north of the northern boundary for the Southern California portion of the HSTT Study Area, northern fur seal colonies are present at Adams Cove on San Miguel Island and on Castle Rock, an offshore island 1.1 km northwest of San Miguel Island (Baird & Hanson, 1997; Melin et al., 2012; Pyle et al., 2001; Stewart & Huber, 1993). Northern fur seal can also occasionally be present on San Nicolas Island during summer (Baird & Hanson, 1997; Melin et al., 2012; Pyle et al., 2001). In aerial surveys of the Channel islands between 2011–2015, the species was only observed at San Miguel Island (Lowry et al., 2017). Animals from the California stock may remain in or near the area throughout the year, but generally move to the North Pacific in waters off Washington, Oregon, and northern California to forage (Carretta et al., 2017c; Koski et al., 1998; Melin et al., 2012; Sterling et al., 2014). In 2005–2006 during a period of cooler ocean temperatures, northern fur seals shifted their distribution from their common occurrence at least 50 km from coast, to being unusually abundant within 10 km of the central California coast (Peterson et al., 2006).

Most northern fur seals, excluding those of the California stock, migrate along continental margins from low-latitude winter foraging areas to northern breeding islands (Gentry, 2009; Ragen et al., 1995). They leave the breeding islands in November and concentrate around the continental margins of the north Pacific Ocean in January and February, where they have access to vast, predictable food supplies and where the Eastern Pacific and the California stocks overlap (Gentry, 2009; Loughlin et al., 1994; Newsome et al., 2007; Ream et al., 2005). Juveniles have been known to conduct trips between 8 and 29 days in duration, ranging from 171 to 680 km (Sterling & Ream, 2004). Adult female fur seals equipped with radio transmitters have been recorded conducting roundtrip foraging trips of up to 740 km (National Marine Fisheries Service, 2007c; Robson et al., 2004).

3.7.2.3.34.3 Population Trends

The abundance of northern fur seals at San Miguel Island, the primary rookery for the California stock, has increased steadily over the past 4 decades, except for two severe declines associated with El Niño-Southern Oscillation events in 1993 and 1998 (Carretta et al., 2015; DeLong & Stewart, 1991; Melin et al., 2006; Melin et al., 2008; Orr et al., 2012). The San Miguel Island population makes up 96 percent of the California stock of northern fur seals (Carretta et al., 2015).

3.7.2.3.34.4 Predator and Prey Interactions

Northern fur seals are opportunistic feeders. The principal prey off California includes northern anchovy, hake, Pacific saury, Pacific whiting, squid, rockfishes, and salmon (Antonelis et al., 1990; Gentry, 2009; Jefferson et al., 2008b; Kajimura, 1984). This species is known to feed along the continental slope and off the shelf; females forage in areas of 100 to 200 m in depth, while males forage in areas greater than 400 m in depth (Calambokidis et al., 2004; Gentry, 2009). Lactating female northern fur seals primarily forage north of San Miguel Island in areas of 200 to 3,000 m; mean depth of 933 m in depth (Antonelis et al., 1990).

This species may be preyed on by killer whales and sharks (Gentry, 2009; Jefferson et al., 2008b).

3.7.2.3.34.5 Species-Specific Threats

Along the U.S. West Coast from 2007 to 2014, there were 19 deaths and 7 serious injuries to northern fur seals due to human-related causes reported; primarily fishing interactions and marine debris entanglement (Carretta et al., 2013b; Carretta et al., 2016b). From a total of 165 northern fur seals reported as stranded along the central California coast between 2003 and 2015, 5 were determined to be caused by entanglement in marine debris, 2 by fishing tackle injuries, and 1 by gunshot (Barcenas De La Cruz et al., 2017).

Counts of northern fur seal from 1972 to 2012 at San Miguel and Castle Rock appear to show that the population is greatly affected and the abundance reduced by El Niño events, which result in animals being in poor physical condition, having reduced reproductive success, and high mortality during those events (Carretta et al., 2017c).

3.7.2.3.35 Northern Elephant Seal (*Mirounga angustirostris*)

3.7.2.3.35.1 Status and Management

The northern elephant seal is not listed under the ESA. The northern elephant seal population has recovered dramatically after being reduced to perhaps no more than 10 to 100 animals surviving in Mexico in the 1890s (Carretta et al., 2010; Hoelzel, 1999; Stewart et al., 1994). Movement and some genetic interchange occur between rookeries, but most elephant seals return to the rookeries where they were born to breed and thus may have limited genetic differentiation (Carretta et al., 2010). There are two distinct populations of northern elephant seals: one that breeds in Baja, Mexico, and a population that breeds in California (Garcia-Aguilar et al., 2018). NMFS considers northern elephant seals in the Study Area to be from the California Breeding Stock, although elephant seals from Baja Mexico frequently migrate north through the Southern California portion of the HSTT Study Area (Aurioles-Gamboa & Camacho-Rios, 2007; Carretta et al., 2017c).

3.7.2.3.35.2 Habitat and Geographic Range

Northern elephant seals are found in both coastal and deep waters of the eastern and central north Pacific. Elephant seals spend more than 80 percent of their annual cycle at sea, making long migrations to offshore foraging areas and feeding intensively to build up the blubber stores required to support them during breeding and molting haulouts (Hindell & Perrin, 2009; Le Boeuf & Laws, 1994; Worthy et al., 1992). Breeding and pupping take place on offshore islands and mainland rookeries (Carretta et al., 2010; Le Boeuf & Laws, 1994). Small colonies of northern elephant seals breed and haul out on Santa Barbara Island and San Clemente Island with large colonies on San Nicolas and San Miguel Islands (Stewart et al., 1993; Stewart et al., 1994); peak abundance is during the January to February breeding season (Lowry et al., 2017). Aerial survey that included all the Channel Islands in July 2015 found the majority (approximately 61 percent) of elephant seals at San Miguel Island, approximately 21 percent at San Nicolas Island, and 18 percent at Santa Rosa Island (Lowry et al., 2017). Elephant seals use these islands as rookeries from late December to February, and to molt from April to July. Northern elephant seals spend little time nearshore, and migrate through offshore waters four times a year as they travel to and from breeding/pupping and molting areas on various islands and mainland sites along the Mexico and California coasts.

With most of their prey found in open oceans, northern elephant seal juveniles and females are often found in deepwater zones, while males also engage in benthic foraging and travel as far north as seamounts in the Gulf of Alaska (Le Boeuf et al., 1996; Le Boeuf et al., 2000; Robinson et al., 2012; Simmons et al., 2007; Simmons et al., 2010; Stewart & DeLong, 1995).

There are records of three northern elephant seals being present in the Hawaiian Islands, indicating that movements beyond their normal range do occur, but are very rare. A female, an immature male, and mature male were sighted on Midway Island in the northwestern Hawaiian Islands in 1978 (Tomich, 1986). On January 2, 2002, a juvenile male elephant seal was discovered on Molokai and reported to be the second confirmed sighting in the main Hawaiian Islands since 2001 (National Marine Fisheries

Service, 2006). This same elephant seal was next encountered on January 11, 2002 on the Kona coast of Hawaii at Kawaihae Beach and later at the Kona Village Resort where it was captured and returned to California by NMFS (Fujimori, 2002).

Northern elephant seals are found in both coastal areas and deeper waters off Southern California (Carretta et al., 2010; Jefferson et al., 2008b; Robinson et al., 2012). The foraging range of northern elephant seals extends thousands of kilometers offshore from the breeding range into the central North Pacific Transition Zone well to the north of Hawaii; however, their range is not considered to be continuous across the Pacific (Simmons et al., 2010; Stewart & Huber, 1993). Adult males and females segregate while foraging and migrating (Simmons et al., 2010; Stewart & DeLong, 1995; Stewart, 1997). Adult females mostly range west to about 173° W, between the latitudes of 40° N and 45° N, whereas adult males range farther north into the Gulf of Alaska and along the Aleutian Islands to between 47° N and 58° N (Le Boeuf et al., 2000; Robinson et al., 2012; Stewart et al., 1993; Stewart & DeLong, 1995). Adults stay offshore during migration, while juveniles are often seen along the coasts of Oregon, Washington, and British Columbia (Le Boeuf et al., 1996; Stewart & Huber, 1993). The most far-ranging individual appeared on Nijima Island off the Pacific coast of Japan in 1989 (Kiyota et al., 1992). This demonstrates the great distances that these animals are capable of covering.

3.7.2.3.35.3 Population Trends

The population in California continues to increase, but the Mexican stock appears to be stable or slowly decreasing (Carretta et al., 2015; Lowry et al., 2014; Stewart & DeLong, 1994). Some evidence indicates that elephant seals may be expanding their pupping range northward, possibly in response to continued population growth (Hodder et al., 1998). Hodder et al. (1998) noted a possible emerging breeding colony at Shell Island off Cape Arago in southern Oregon. Other northern mainland breeding rookeries include Ano Nuevo, Point Reyes and Cape San Martin (Stewart et al., 1994).

3.7.2.3.35.4 Predator and Prey Interactions

The diet of the northern elephant seal is known to include 53 different prey species (Antonelis et al., 1994; Jefferson et al., 2008b). They primarily feed on cephalopods, hake, and other near-surface and mid-water fishes and crustaceans, such as pelagic red crabs as well as open ocean prey and bottom-dwelling prey (Stewart & Huber, 1993). This species is not known to feed in the Study Area. Elephant seals from the Mexico breeding stock probably feed farther south and over a broader longitudinal scale than those from the California breeding stock (Aurioles-Gamboa & Camacho-Rios, 2007). Male and female northern elephant seals are known to conduct different foraging strategies. Males feed near the eastern Aleutian Islands and in the Gulf of Alaska, and females feed farther south, south of 45° N (Carretta et al., 2010; Stewart & Huber, 1993). Females range widely over deep water, apparently foraging on patchily distributed, vertically-migrating, open ocean prey (Le Boeuf et al., 2000). Males forage along the continental margin at the end of their migration and may feed on bottom-dwelling prey (Le Boeuf et al., 2000). Given concerns over the impact of climate change on prey availability, a study of Northern elephant seals has 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).

3.7.2.3.35.5 Species-Specific Threats

In 2013, two elephant seals were observed interacting with the deep-set and shallow-set longline fisheries north of the Hawaiian Exclusive Economic Zone, resulting in one serious injury (Bradford & Forney, 2017). There were 34 deaths and 18 serious injuries to northern elephant seals along the U.S.

West Coast from 2011 to 2015 due to human-related causes, with oil-related injuries, fishery interactions, and shootings identified as leading causes (Carretta et al., 2017b). From a total of 1,831 elephant seals reported as stranded along the central California coast between 2003 and 2015, 35 were determined to be caused by entanglement in marine debris, 4 by fishing tackle injuries, and 2 by boat collisions (Barcenas De La Cruz et al., 2017).

Northern elephant seals are preyed on by killer whales and great white sharks, which have been known to group around the haulout and rookery sites of this species (Hindell & Perrin, 2009; Jefferson et al., 2008b; Klimley et al., 2001; Kuhn & Costa, 2014).

3.7.2.3.36 Harbor Seal (*Phoca vitulina*)

3.7.2.3.36.1 Status and Management

The harbor seal is not listed under the ESA. The Society of Marine Mammalogy's Committee on Taxonomy (2016) has determined that all harbor seals in the north Pacific should be recognized as a single subspecies (*Phoca vitulina richardii*) until the subspecies limits of various populations are better known. There are 17 stocks of harbor seal along the U.S. West Coast (Carretta et al., 2017c; Muto et al., 2016); there is a single California stock occurring within the Southern California portion of the HSTT Study Area.

3.7.2.3.36.2 Habitat and Geographic Range

The harbor seal is one of the most widely-distributed seals, found in nearly all temperate coastal waters of the northern hemisphere (Jefferson et al., 2008b). Harbor seals are generally not present in the open ocean. Harbor seals are not present in the Hawaii portion of the HSTT Study Area.

Harbor seals, while primarily aquatic, also use the coastal terrestrial environment, where they haul out of the water periodically. Harbor seals are a coastal species, rarely found more than 20 km from shore, and frequently occupying bays, estuaries, and inlets (Baird, 2001; Harvey & Goley, 2011). Individual seals have been observed several kilometers upstream in coastal rivers (Baird, 2001). Harbor seals are not considered migratory (Burns, 2009; Carretta et al., 2018a; Harvey & Goley, 2011; Jefferson et al., 2008b), and data from 180 radio-tagged harbor seals in California indicated most remained within 10 km of the location where they were captured and tagged (Harvey & Goley, 2011).

Ideal harbor seal habitat includes suitable haulout sites, shelter from high surf during the breeding periods, and sufficient food near haulout sites to sustain the population throughout the year (Bjorge, 2002). Haulout sites vary, but include intertidal and subtidal rock outcrops, sandbars, sandy beaches, estuaries, and even peat banks in salt marshes (Burns, 2009; Gilbert & Guldager, 1998; Prescott, 1982; Schneider & Payne, 1983; Wilson, 1978).

Small numbers of harbor seals are found hauled out on coastal and island sites and forage in the nearshore waters of the Southern California Range Complex, but are found in only moderate numbers compared to sea lions and elephant seals. Peak abundance for harbor seals in southern California is during the late-May to early-June molt season (Lowry et al., 2017). In California, approximately 400 to 600 harbor seal haulout sites are widely distributed along the mainland and on offshore (Lowry et al., 2008; Lowry et al., 2017). The harbor seal haulout sites in the San Diego area include mainland beaches and all of the Channel Islands, including Santa Barbara, Santa Catalina, and San Nicolas Islands (Lowry et al., 2008). There were 1,367 harbor seals counted in the Channel Islands during aerial surveys in July 2015 (Lowry et al., 2017). Individuals have also been observed hauled out at La Jolla Cove, and within the channel of San Diego Bay at Ballast Point and Navy Base Point Loma. Monitoring during a pier replacement project in Point Loma (October 2014 to April 2015) encountered a mean number of 3 harbor seals hauled out and 2.00 to 2.48 per day in the water (U.S. Department of the Navy, 2015b). A total of 15 harbor seals were sighted off the coast during 18 aerial surveys conducted between 2008 and 2013 in the Southern California portion of the HSTT Study Area (Jefferson et al., 2014). There were no harbor seals detected in the 17 days of surveys (between October 2013 and September 2014) nearshore off the Silver Strand Training Complex and San Diego Bay (Graham & Saunders, 2015).

3.7.2.3.36.3 Population Trends

The most recent (2012) statewide survey of California harbor seal rookeries has indicated that in the Channel Islands the count has been stable or trending as a slight increase since 1995 (Carretta et al., 2015; Carretta et al., 2017c). In the short term, this trend may be affected by the two pinniped Unusual Mortality Events that has been ongoing on the U.S. West Coast since 2013 (National Oceanic and Atmospheric Administration, 2018a, 2018b). As noted above, survey of the Channel Islands in July 2015 counted 1,367 harbor seals in that subset of the California population (Lowry et al., 2017), but there was not comparative information from 2012–2015 to allow for examination of the trend over that period.

3.7.2.3.36.4 Predator and Prey Interactions

The main prey species of the harbor seal are cod, some rockfish species, sand eels, herring, and capelin. Harbor seals are also known to feed on cephalopods. Pups feed on bottom-dwelling crustaceans during their first few weeks of foraging. Sand eels are the main prey for individuals foraging in the south of their range, while cod is the main prey for other geographic areas included in the harbor seal range. There is no seasonal variation in prey species, but capelin and herring are more numerous in the fall and winter (Gibble & Harvey, 2015; Grigg et al., 2009; Hauksson & Bogason, 1997; Jefferson et al., 2008b; Reeves et al., 1992). Harbor seals are known to be preyed on by killer whales, sharks, eagles, ravens, gulls, and coyotes (Burns, 2009; Weller, 2009).

3.7.2.3.36.5 Species-Specific Threats

There were a reported 160 deaths and 41 serious injuries to harbor seals along the U.S. West Coast from 2010 to 2014 due to human-related causes; primarily from shore-based electrical power plant intake entrainment (Carretta et al., 2016b). Out of a total of 1,071 harbor seals reported as stranded along the central California coast between 2003 and 2015, 4 were determined to be caused by entanglement in marine debris, 4 by fishing tackle injuries, 4 by boat collisions, and 2 by gunshots (Barcenas De La Cruz et al., 2017).

3.7.3 Environmental Consequences

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) potentially impact marine mammals known to occur within the Study Area. Tables 2.6-1 through 2.6-5 present the proposed training and testing activity locations for Alternatives 1 and 2. The stressors vary in intensity, frequency, duration, and location within the Study Area. General characteristics of all Navy stressors were introduced in Section 3.0.3.3 (Identification of Stressors for Analysis), and living resources' general susceptibilities to stressors were introduced in Section 3.0.3.6 (Biological Resource Methods). The stressors analyzed for marine mammals are:

- **Acoustic** (sonar and other transducers, air guns, pile driving, vessel noise, aircraft noise, and weapons noise)
- **Explosives** (explosions in air; explosions in water)
- **Energy** (electromagnetic devices, high-energy lasers, radar)

- **Physical disturbance and strike** (vessels and in-water devices, military expended materials, seafloor devices, pile driving)
- **Entanglement** (wires and cables, decelerators/parachutes, biodegradable polymer)
- **Ingestion** (military expended materials - munitions, military expended materials other than munitions)
- **Secondary stressors** (impacts on habitat, impacts on prey availability)

In this analysis, marine mammal species are grouped together based on similar biology (e.g., hearing) or behaviors (e.g., feeding or expected reaction to stressors) when most appropriate for the discussion. In addition, for some stressors, species are grouped based on their taxonomic relationship and discussed as follows: mysticetes (baleen whales), odontocetes (toothed whales), pinnipeds (seals and sea lions), and mustelids (sea otter).

When impacts are expected to be similar to all species or when it is determined there is no impact on any species, the discussion will be general and not species-specific. However, when impacts are not the same to certain species or groups of species, the discussion will be as specific as the best available data allow. In addition, if activities only occur in or will be concentrated in certain areas, the discussion will be geographically specific. Based on acoustic thresholds and criteria developed with NMFS, impacts from sound sources as acoustic stressors will be quantified at the species or stock level as is required pursuant to authorization of the proposed actions under the MMPA.

The analysis includes consideration of the mitigation that the Navy will implement to avoid or reduce potential impacts on marine mammals from acoustics, explosives, and physical disturbance and strike stressors. Mitigation for marine mammals has been coordinated with NMFS and the USFWS through the consultation processes.

3.7.3.1 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). Furthermore, 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 the Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities (Section 3.0.3.6.1). 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 3.7.3.1.1.1, Injury). Hearing loss (Section 3.7.3.1.1.2, Hearing Loss) is a noise-induced decrease in hearing sensitivity, which can be either temporary or permanent. Masking (Section 3.7.3.1.1.4, Masking) can occur when the perception of a biologically important sound (i.e., signal) is interfered with by a second sound (i.e., noise). Physiological stress

(Section 3.7.3.1.1.3, Physiological Stress) is an adaptive process that helps an animal cope with changing conditions, however too much stress can potentially result in additional physiological effects. Behavioral response (Section 3.7.3.1.1.5, 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 3.7.3.1.1.6, Stranding). Long-term consequences (Section 3.7.3.1.1.7, 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).

3.7.3.1.1 Background

3.7.3.1.1.1 Injury

Injury (i.e., physical trauma) refers to the effects on the tissues or organs of an animal due to exposure to pressure waves. Injury due to exposure 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 any injury. The Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities (see Section 3.0.3.6.1) 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 realistic conditions during training and testing activities, and this type of impact is not considered further in this analysis.

Nitrogen Decompression

Marine mammals are thought to deal with nitrogen loads in their blood and other tissues, caused by gas exchange from the lungs under conditions of high ambient pressure during diving, through anatomical, behavioral, and physiological adaptations (Hooker et al., 2012).

Although not a direct injury, variations in marine mammal diving behavior or avoidance responses have been hypothesized to result in nitrogen off-gassing in 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”). The process has been under debate in the scientific community (Hooker et al., 2012; Saunders et al., 2008), although analyses of by-caught and drowned animals have demonstrated that nitrogen bubble formation can occur in animals that no longer exchange gas with the lungs (drowned) and which are brought to the surface where tissues become supersaturated with nitrogen due to the reduction in hydrostatic pressure (Bernaldo de Quiros et al., 2013b; Moore et al., 2009). Deep diving whales, such as beaked whales, have been predicted to have higher nitrogen loads in body tissues for certain modeled changes in dive behavior, which might make them more susceptible to decompression (Fahlman et al., 2014b; Fernandez et al., 2005; Hooker et al., 2012; Jepson et al., 2003).

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 (Fahlman et al., 2014b). To examine the potential for gas bubble formation, a bottlenose dolphin was trained to dive repetitively to depths shallower than lung collapse to elevate nitrogen saturation to the point that asymptomatic nitrogen bubble formation was predicted to occur. However, inspection of the vascular system of the dolphin via ultrasound did not demonstrate the formation of any nitrogen gas bubbles (Houser et al., 2009). 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 indicated that venous supersaturation was within the normal range for these species, which have naturally high levels of nitrogen loading.

Still, little is known about respiratory physiology of deep-diving breath-hold animals. Costidis and Rommel (2016) suggest 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, contributing to tissue gas loads. Researchers have also considered the role of carbon dioxide accumulation 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, may facilitate the formation of bubbles in nitrogen saturated tissues (Bernaldo de Quiros et al., 2012; Fahlman et al., 2014b). Parraga et al. (2018) suggest that diving marine mammals have physiological and anatomical adaptations to control gas uptake above the depth of lung collapse, favoring oxygen uptake while minimizing nitrogen uptake. Under the hypothesis of Parraga et al. (2018), elevated activity due to a strong evasive response could lead to increased uptake of nitrogen, resulting in an increased risk of nitrogen decompression.

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). The presence of osteonecrosis (bone death due to reduced blood flow) in deep diving sperm whales has been offered as evidence of chronic supersaturation (Moore & Early, 2004). Proposed adaptations for prevention of bubble formation under conditions of persistent tissue saturation have been suggested (Fahlman et al., 2006; Hooker et al., 2009), while the condition of supersaturation required for bubble formation in these tissues has been demonstrated in marine mammals drowned at depth as fisheries bycatch and brought to the surface (Moore et al., 2009). For beaked whale strandings associated with sonar use, one theory is that observed bubble formation might be caused by long periods of compromised blood flow caused by the stranding itself (which reduces ability to remove nitrogen from tissues) following rapid ascent dive behavior that does not allow for typical management of nitrogen in supersaturated, long-halftime tissues (Houser et al., 2009).

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. Although rare, similar findings have been found in the Risso's dolphin, another deep diving species, but with presumably non-anthropogenic causes (Fernandez et al., 2017).

Dennison et al. (2012) reported on investigations of dolphins stranded in 2009–2010 and, using ultrasound, identified gas bubbles in kidneys of 21 of the 22 live-stranded dolphins and in the livers 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. The researchers concluded that the minor bubble formation observed could be tolerated since the majority of stranded dolphins released did not re-strand.

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," 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 that 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 level would only occur in very close proximity to the most powerful sonars. 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).

3.7.3.1.1.2 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 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 may range from slight to profound, depending on the ability of the individual to hear at the affected frequencies.

The Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities (see Section 3.0.3.6.1) 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 threshold shift 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 3.7-4 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 hr. post-exposure indicates a more hazardous exposure than one producing 20 dB of TTS measured only 2 min after exposure; if the TTS is 20 dB after 24 h, the TTS measured after 2 min would have likely been much higher. Conversely, if 20 dB of TTS was measured after 2 min, the TTS measured after 24 hr. 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 hr. 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 hr. 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 to 50 dB measured 24 hr. after exposure)—but no PTS—may result in auditory injury.

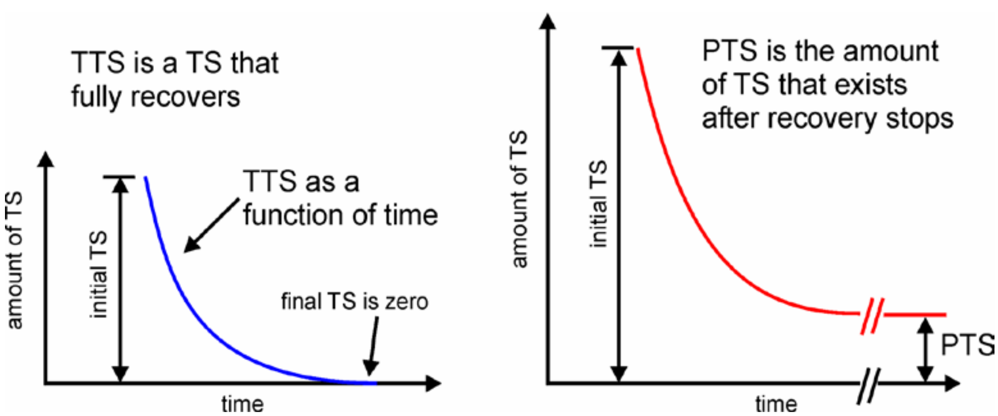


Figure 3.7-4: Two Hypothetical Threshold Shifts

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

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 in the same individual; conversely, if an initial threshold shift only partially recovers, resulting in some amount 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. Exposure thresholds for the occurrence of PTS or other auditory injury can therefore be defined based on a specific amount of TTS; i.e., although an exposure has been shown to produce only TTS, 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 threshold shifts up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for allowable threshold shift to prevent PTS (e.g., Kryter et al., 1965; Miller et al., 1963; Ward et al., 1958; Ward et al., 1959; Ward, 1960). 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 et al., 2005a; Finneran, 2015; Ketten, 2000). Therefore, we assume that sound exposures sufficient to produce 40 dB of TTS measured ~4 min 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 ~4 min 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 measures producing larger amounts of TTS compared to psychophysical measures (Finneran et al., 2007; Finneran, 2015).
- The amount of TTS varies with the hearing test frequency. As the exposure SPL increases, the frequency at which the maximum TTS occurs also increases (Kastelein et al., 2014b). For high level exposures, the maximum TTS typically occurs one-half to one octave above the exposure frequency (Finneran et al., 2007; Mooney et al., 2009b; Nachtigall et al., 2004; Popov et al., 2011; Popov et al., 2013; 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., 2014b; 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.

- 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 necessary to produce 6 dB of TTS (i.e., clearly above the typical variation in threshold measurements)—also varies with exposure frequency. At low frequencies onset-TTS exposure levels are higher compared to those in 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., 2014c; Kastelein et al., 2015b; 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., ~40 dB) may require several days for recovery. 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., 2014b; Kastelein et al., 2014c; Popov et al., 2011; Popov et al., 2013; Popov et al., 2014). 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).

Due to the higher exposure levels or longer exposure durations required to induce hearing loss, only a few types of man-made sound sources have the potential to cause a threshold shift 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.

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., 2005b; Finneran et al., 2010a; Finneran & Schlundt, 2013; Mooney et al., 2009a; Mooney et al., 2009b; Nachtigall et al., 2003; Nachtigall et al., 2004; Popov et al., 2013; Popov et al., 2014; 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., 2012b) 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, 2017a), and the major findings are summarized above.

Threshold Shift due to Impulsive Sound Sources

Marine mammal 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 to 20 dB in a harbor porpoise exposed to single impulses from a seismic air gun.

In addition to these data, Kastelein et al. (2015a) reported behaviorally-measured mean TTS of 4 dB at 8 kHz and 2 dB at 4 kHz after a harbor porpoise was exposed to a series of impulsive sounds produced by broadcasting underwater recordings of impact pile driving strikes through underwater sound projectors. The cumulative SEL was approximately 180 dB re 1 $\mu Pa^2 s$. The pressure waveforms for the simulated pile strikes exhibited significant "ringing" not present in the original recordings and most of the energy in the broadcasts was between 500 and 800 Hz. As a result, some questions exist regarding whether the fatiguing signals were representative of underwater pressure signatures from impact pile driving.

Several impulsive noise exposure studies have also been conducted without behaviorally measurable TTS. 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 $\mu Pa^2 s$, 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 $\mu Pa^2 s$, peak SPL = 183 dB re 1 µPa).

3.7.3.1.1.3 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; New et al., 2013b; 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 effects 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). 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.

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) in marine mammals might be different than in 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 might 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 pronounced increase in 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). 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 acclimated to the noise exposure. Kvadsheim et al. 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 vs. 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 dive bradycardia persists during diving and might be enhanced in response to an acute stressor.

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 affect 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 prohibited 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., 2006; Williams et al., 2009; Williams et al., 2014b; Williams et al., 2014c). 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, 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 (King et al., 2015; e.g., New et al., 2013a; New et al., 2013b; 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).

3.7.3.1.1.4 Masking

Masking occurs when one sound, distinguished as the "noise," interferes with the detection or recognition of another sound. The quantitative definition of masking is the amount in decibels an auditory detection or discrimination threshold is raised in the presence of a masker (Erbe et al., 2016). As discussed in Section 3.0.3.6.1 (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).

Critical ratios are the lowest signal-to-noise ratio in which detection 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 μPa^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 (Figure 3.7-5) (Au & Moore, 1990; Johnson et al., 1989; Kastelein & Wensveen, 2008; Lemonds et al., 2011; Thomas et al., 1990a), manatees (Gaspard et al., 2012), and sea otters (Ghoul & Reichmuth, 2014a). Critical ratios are directly related to the bandwidth of auditory filters; as a result, 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. Although critical ratios are typically estimated in controlled laboratory conditions using Gaussian (white) noise, critical ratios can vary considerably depending on the noise type (Branstetter et al., 2013; Trickey et al., 2010).

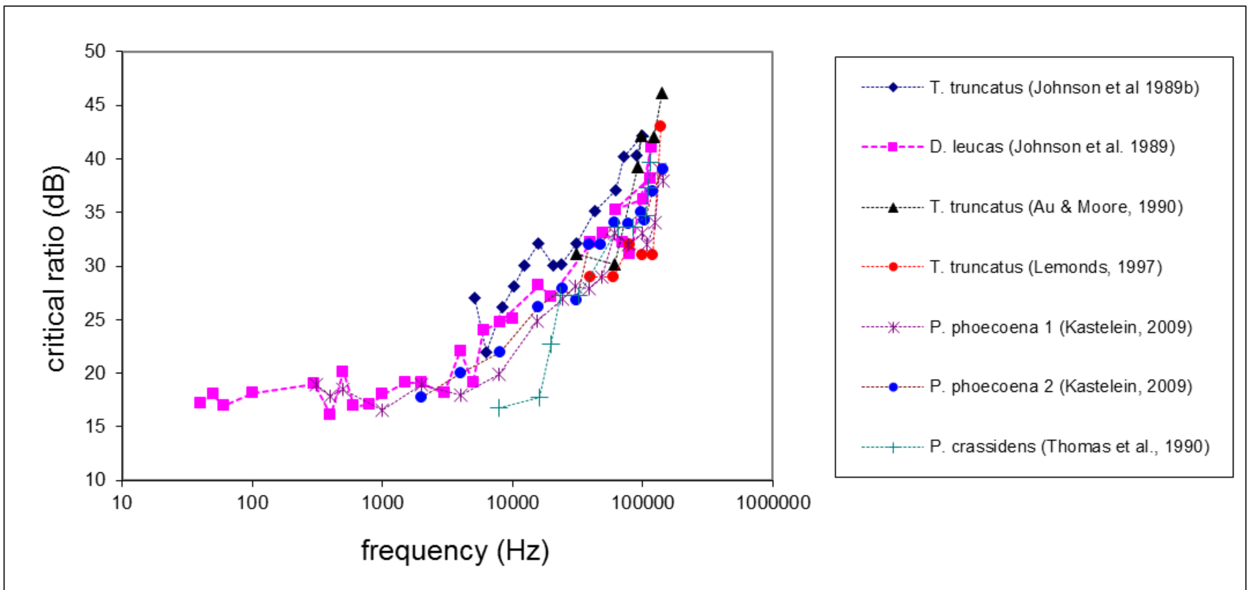


Figure 3.7-5: Critical Ratios (in dB) Measured in Different Odontocetes Species (from Finneran & Branstetter, 2013)

Clark et al. (2009) developed a method for estimating masking effects on communication signals for low-frequency cetaceans, including calculating the cumulative impact of multiple noise sources. For example, their technique calculates 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 may result from a need to compete with an increase in background noise and 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., 2008; Holt et al., 2011; Lesage et al., 1999; McDonald et al., 2009; Rolland et al., 2012) as well as changes in the natural acoustic environment (Dunlop et al., 2014). Vocal changes can be temporary, or can be permanent, as seen in the increase in starting frequency for the North Atlantic right whale upcall over the last 50 years (Tennessen & Parks, 2016). This shift in frequency was modeled, and it was found that it led to 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 also move beyond vocal modifications (Dunlop et al., 2010). These changes all represent possible tactics by the sound-producing animal to reduce the impact of masking. The receiving animal can also reduce masking by using active listening strategies such as orienting to the sound source, moving to a different location to improve binaural cues (time or intensity differences between the ears due to a sound source's location relative to the animal's head), or going still to reduce noise associated with hydrodynamic flow. The structure of some noises (e.g., amplitude modulation) may also provide some release from masking through comodulation masking release (the difference in masking when a noise is broadband versus having the same bandwidth as the signal) (Branstetter & Finneran, 2008; Branstetter et al., 2013). Signal characteristics (e.g., whether the signal has harmonics, or is frequency modulated) may further enhance the detectability of a signal in noise (Cunningham et al., 2014).

Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators (Allen et al., 2014; Cummings & Thompson, 1971; Curé et al., 2015; Fish & Vania, 1971), which 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 identification of predator cues are impeded. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke et al., 2002), a capability that should increase survivorship while reducing the energy required 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 as a Result of Impulsive Noise

Masking could occur in mysticetes due to the overlap between their low-frequency vocalizations and the dominant frequencies of air gun pulses, however, masking in odontocetes or pinnipeds is less likely unless the seismic survey 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 (Dilorio & Clark, 2010), indicative of a possible compensatory response to the increased noise level. 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^2s cumulative SEL the call rate began decreasing, and stopped altogether once received levels reached 170 dB re 1 µPa^2s 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 ms 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).

Masking as a Result of Sonar and Other Transducers

Masking as a result of duty-cycled low-frequency or mid-frequency active sonar with relatively low duty cycles is unlikely for most cetacean and pinnipeds as sonar tones occur over a relatively short duration and narrow bandwidth that does not overlap with vocalizations for most marine mammal species. While dolphin vocalizations can occur in the same bandwidth as mid-frequency active sonar, the duty cycle of most low-frequency and mid-frequency active sonars are low enough that delphinid whistles might be masked only a small percentage of the time they are whistling, and so masking by sonar would not likely have any short- or long-term consequences. 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 also 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 to 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 of these systems limits the range of impact compared to more 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 a number of 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 as a Result of Vessel and Vibratory Pile Driving Noise

Masking is more likely to occur in the presence of broadband, relatively continuous noise sources such as vessels and vibratory pile driving. 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). Although humpback whales 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).

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 due to vessel traffic noise, and in peak traffic hours lose up to 97 percent of that space. Holt et al. (2008; 2011) showed that southern resident killer whales in the waters surrounding the San Juan Islands increased their call source level as vessel noise increased. Hermannsen et al. (2014) estimated that broadband vessel noise could extend up to 160 kHz at ranges from 60 to 1200 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 so 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. Dugong vocalizations were recorded in the presence of passing boats, and although the call rate, intensity or frequency of the calls did not change, the duration of the vocalizations was increased, as was the presence of harmonics. This may indicate more energy was being used to vocalize in order to maintain the same received level (Ando-Mizobata et al., 2014). Gervaise et al. (2012) estimated that beluga whales in the St. Lawrence Marine Park had their estimated communication space under typical background noise conditions already reduced to 30 percent due to vessel traffic, which was further reduced to only 15 percent of their communication space during peak vessel traffic hours coinciding with the arrival and departure of whale watching vessels. Lesage et al. (1999) found belugas in the St. Lawrence River estuary to reduce overall call rates but increase the production of certain call types when ferry and small outboard motor boats were approaching, and to increase 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.

Vibratory pile driving noise is a continuous, broadband noise source similar to vessel noise. Wang et al. (2014) found that whistles of humpback dolphins could be masked by a very large vibration pile driving hammer within 200 m, but clicks would not be masked.

3.7.3.1.1.5 Behavioral Reactions

As discussed in the Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities (Section 3.0.3.6.1), any stimulus in the environment can cause a behavioral response in marine mammals. These stimuli include noise from anthropogenic sources such as vessels, sonar, air guns, or pile driving, but could also include the physical presence of a vessel or aircraft. However, these stimuli could also influence how or if a marine mammal responds to a sound such as the presence of predators, prey, or conspecifics. 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 (Gomez et al., 2016; 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. 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 (Harris et al., 2018; Southall et al., 2007; Southall et al., 2016). 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, 2017a)). 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, including impulsive sources such as explosives, air guns, and impact pile driving, and non-impulsive sources such as sonar and other transducers (e.g., pingers), and vessel and aircraft noise. For some of these noise sources numerous studies exist (e.g., sonar), whereas for others the data are sparse (e.g., pile driving), and surrogate sound sources must be relied upon to assess the potential for behavioral response. Similarly, 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, 2017a)).

Behavioral Reactions to Impulsive Sound Sources

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. Data on behavioral responses to impulsive sound sources are limited across all marine mammal groups, with only a few studies available for mysticetes, odontocetes, and pinnipeds. No data currently exist for 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 Navy impulsive sources analyzed in this document such as single air guns and small, short-duration pile driving activities.

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 when 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 6–8 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).

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^{2}s (Dilorio & 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 116–129 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^{2}s cumulative SEL, and ceased altogether at received levels over 170 dB re 1 µPa^{2}s 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 when the 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., pile driving), short term (on the order of hours rather than days or weeks), and lower source level (e.g., swimmer defense air guns) 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 nautical miles (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.

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 pile driving, the avoidance distance appeared to be reduced to half that distance (12 km), and the response only lasted about 5 hours rather than a day before the animals returned to the area (Dähne et al., 2017). Kastelein et al. (2013b) exposed a captive harbor porpoise to impact pile driving sounds, and 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, 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.

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 3.7.3.1.1.2, 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 impact on sea otters in California; foraging and dive behaviors remained undisturbed, as did the density and distribution of sea otters in the area (Reidman, 1983). 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. If reactions 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. Additionally, sea otters are predicted to live too far inshore to be disturbed by the construction (involving pile driving) or operation of offshore wind farms (Inger et al., 2009; Michel et al., 2007). Although pile driving during pier construction occurs inshore, it would not occur in areas that overlap the current range of sea otters (U.S. Fish and Wildlife Service, 2016).

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 3.0.3.6.1 (Conceptual Framework) and Section 3.7.3.1.1.5 (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 min) of ramp-up (von Benda-Beckmann et al., 2014; von Benda-Beckmann et al., 2016). 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., 2015b; 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 (Campbell et al., 2010; Farak et al., 2011; HDR, 2011a; Norris et al., 2012a; Smultea & Mobley, 2009; Smultea et al., 2009; Trickey et al., 2015; U.S. Department of the Navy, 2011a, 2013c, 2014a, 2015a). 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 carcasses were observed but all were in an advanced state of decomposition and were therefore judged to have been deceased prior to the event) (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 & 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

As with impulsive sounds, 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., 2015b; 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 (DeRuiter et al., 2017; Goldbogen et al., 2013; Sivle et al., 2015). 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., 2015). 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). 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., 2004a). 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.

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 & Milette, 2010; Mobley, 2011; 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, 2011b). 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).

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. (2015b) 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, 2013c), especially with an increased ping rate (Charif et al., 2015). Two minke whales also stranded in shallow water after the US 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 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).

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. (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., 2004a), 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, 2011a, 2014b; 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 (Claridge et al., 2009; Defence Science and Technology Laboratory, 2007; Manzano-Roth et al., 2013; McCarthy et al., 2011; Moretti et al., 2009; Southall et al., 2011; Southall et al., 2012; Southall et al., 2013; Southall et al., 2014; Southall et al., 2015; 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, 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; Falcone et al., 2017; Miller et al., 2015; Southall et al., 2011; Stimpert et al., 2014; Tyack et al., 2011). A similar response was observed in a northern bottlenose whale, 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 7 hours (Miller et al., 2015). Responses occurred at received levels between 95 and 150 dB re 1 µPa; although all 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., 2013a). 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 to 25 km in this study). 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. 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) were among the longest found by Schorr et al. (2014) and Falcone et al., (2017), and 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.

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., 2015b; Manzano-Roth et al., 2016; McCarthy et al., 2011; Moretti et al., 2009; Tyack et al., 2011). 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 7 years apart, indicating a possibly resident population on the range (Falcone et al., 2009; Falcone & Schorr, 2014).

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 4 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.

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). 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 et al., 2011; Miller, 2012). 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).

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, changes in behavioral state, and changes in dive behavior (Antunes et al., 2014; Miller et al., 2011; Miller, 2012; 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 1µPa) and sperm whales (mean 140 dB re 1µPa) than killer whales (mean 129 dB re 1µPa) (Antunes et al., 2014; Miller, 2012; Miller et al., 2014). A close examination of the tag data from the Norwegian groups showed that responses seemed to be behaviorally or signal frequency mediated. 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, 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. 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). These results again demonstrate that the behavioral state of the animal mediates the likelihood of a behavioral response, as do the characteristics (e.g., frequency) of the sound source itself.

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., 2012a). 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, 2013b).

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. (2013b; 2014a; 2017) 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 island-associated 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. Navy monitoring in the Hawaii Range Complex has resulted in tags being deployed on seven false killer whales prior to Submarine Command Course and contributed valuable information on the occurrence and movements of false killer whale. Only one individual's movements in space and time lent itself to detailed analysis of exposure and response. The false killer whale passed through the range twice, receiving an estimated median received level of 156 dB re 1 µPa with a maximum estimated received level of 188 dB re 1 µPa on August 12 (Baird et al., 2016). Despite this exposure, the animal remained in the vicinity for two more days, and passed through the Submarine Command Course again, continuing to be exposed to mid-frequency acoustic sonar. This animal's lack of observable behavioral response to mid-frequency active sonar is consistent with bottlenose dolphins, rough-toothed dolphins, and pilot whales for which analysis of this kind has also been conducted from Pacific Missile Range Facility data (Baird et al., 2014a; Baird et al., 2014b). 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, 2003) estimated a mean received SPL of approximately 169 dB re 1µPa 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 1µPa). 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 Fisheries, 2014). 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 & Schevill, 1975; Watkins et al., 1985). 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 bowride, while spotted dolphins were observed nearby but did not avoid or approach the vessel (HDR, 2011b; U.S. Department of the Navy, 2011b; 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 a seasonal difference that was also observed in other years (Campbell et al., 2010). There were also fewer passive acoustic dolphin detections during and after longer sonar activities in the Marianas 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 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 2–4 exposures, longer term exposures (over 28 days) showed no evidence of additional habituation. 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). 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). 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., 2017). 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., 2013), and in another study bottlenose dolphins and beluga whales were presented with 1-second tones up to 203 dB re 1 μPa to measure TTS (Finneran et al., 2001; Finneran et al., 2003a; Finneran & Schlundt, 2004; Finneran et al., 2005b; 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 experiment, bottlenose dolphins demonstrated a 50 percent probability of response at 172 dB re 1 μPa over 10 trials, and in the TTS study bottlenose dolphins exposed to 1-second intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μPa, and 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., 2005), and tones, including 1−2 kHz and 6−7 kHz sweeps with and without harmonics (Kastelein et al., 2014d), and 25 kHz with and without sidebands (Kastelein et al., 2015e; Kastelein et al., 2015f). 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., 2014d). 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., 2014d). 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 didn't have an avoidance response until 151 dB re 1 μPa (Kastelein et al., 2014a). 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.

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., 2013). 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 2 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).

The only study on responses of monk seals to Navy training and testing was D’Amico (2013) where animal movements obtained from telemetry tag data was compared to concurrent mid-frequency active sonar activity. Specifically, positional data was collected by 13 global positioning system telemetry tags deployed over a two-year period (2010–2011) on 11 individual Hawaiian monk seals, for a total of 38,232 hours (1,593 days). By using geospatial databases, it was determined that four of the eight seals were exposed to a total of 14.48 hours (less than 1 day) of mid-frequency sonar activity while the seal was within 36 km of a hull mounted sonar ship. Independently, the tag data were analyzed by the HMSRP to identify specific dates where seal behaviors differed from “normal” for each individual. The time periods determined by HMSRP to be outside the “normal” range were compared to those time periods when a monk seal was in the vicinity of a hull mounted sonar ship while it was transmitting. The available data suggest there were no significant impacts from MFAS on the Hawaiian monk seals tagged in HRC during the 2010–2011 time period, as no outlier days occurred on the day of active transmissions.

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, however 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., 2013; 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). 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 Vessels

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.

Cargo ships, bulk carriers and tankers account for almost three fourths of commercial vessel traffic in the HSTT Study Area, which occurs throughout the Study Area but is heaviest along the coast of California and near the major Hawaiian Islands (Mintz, 2012; Mintz, 2016). Annual commercial vessel traffic in HSTT was estimated to be almost 900,000 hours in 2009, compared to just under 100,000 hours for Navy vessel traffic, which was generally concentrated is the easternmost part of the Southern California region and in the area near Honolulu (Mintz, 2012; Mintz, 2016). Within the Hawaii portion of the HSTT Study Area, 89 percent of the vessel traffic is non-military (civilian) vessels; within the Southern California portion of the HSTT Study Area, 96 percent of the vessel traffic is non-military (civilian) vessels (Mintz, 2016).

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 (Aguilar de Soto et al., 2006; 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 less so. 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; Gende et al., 2011; Watkins, 1981). Other common responses include changes in vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions (Au & Green, 2000; Richter et al., 2003; Williams et al., 2002a).

The likelihood of response may be driven by the distance or speed 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 to 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. 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., 2004a). 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., 2004a; 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., 2009). 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. An increase in feeding call rates and repetition by humpback whales in Alaskan waters is associated with vessel noise (Doyle et al., 2008), while decreases in singing activity have been noted near Brazil due to boat traffic (Sousa-Lima & Clark, 2008). Frequency parameters of fin whale calls also decreased in the presence of increasing background noise due to shipping traffic (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.

The long-term consequences of vessel noise are not well understood (see Section 3.7.3.1.1.7, 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 2000 m of blue whales 70 percent of the time, with a maximum of eight vessels observed within 400 m of one whale at the same time. This study found reduced surface time, fewer breaths at the surface, 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 3.7.3.4, Physical Disturbance and Strike Stressors).

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 increasing and foraging decreasing (Cecchetti et al., 2017; 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; Gregory & Rowden, 2001; Janik & Thompson, 1996; Lusseau, 2004; 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 mile 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 and 116 dB re 1 µPa. While new regulations on the distance boats had to maintain were implemented, there didn't 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., 2002b; Williams et al., 2009). 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 meters; 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 one to two animals and in response 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). The vaquita, which is closely related to the harbor porpoise, appears to avoid large vessels at about 900 m (Jaramillo-Legorreta et al., 1999).

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, 2017; 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 bowride, indicating either that these species are less sensitive to vessels, or that the behavioral drive to bowride 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. (Jones et al., 2017) also 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, with 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 any of these high overlap areas.

Sea Otters

Sea otters 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 in sea otters when compared to pinnipeds (Ghoul & Reichmuth, 2014a, 2014b), so 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. 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).

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 helicopters, as well as unmanned aerial systems. Thorough reviews of the subject and available information is presented in Richardson et al. (1995b) and elsewhere. (Efroymson et al., 2001; Holst et al., 2001; 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. Christiansen et al. (2016b) measured the in air and underwater noise levels of two unmanned aerial systems, 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 system 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. (304.8 m) above sea level, infrequently observed at 1,500 ft. (457.2 m), and not observed at all at 2,000 ft. (609.6 m) (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., 1998; Koski et al., 2015). Similarly, Christiansen et al. (2016a) did not observe any responses to an unmanned aerial system flown 30–120 m above the water when taking photos of humpback whales to conduct photogrammetry and assess fitness. 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-id 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., 2003; Richter et al., 2006; 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).

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, odontocete responses may increase with reduced altitude, due either to noise or the shadows created by the vehicle (Smith et al., 2016).

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 Nicholas 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 Nicholas 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 system 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 or missile overflights. 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 and missile overflight 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 overflight noise. However, there has been no evidence that any aircraft or missile overflight has had adverse effects on the translocated colony of sea otters at San Nicolas Island or in the Southern California portion of the Study Area (U.S. Department of the Interior et al., 2011; U.S. Fish and Wildlife Service, 2012a, 2015).

3.7.3.1.1.6 Stranding

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). 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).

Natural factors related to strandings include limited food availability or following prey inshore, predation, disease, parasitism, natural toxins, echolocation disturbance, climatic influences, and aging (Bradshaw et al., 2006; Culik, 2004; Geraci et al., 1999; Geraci & Lounsbury, 2005; 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., 2012; Saez et al., 2013), human activities (e.g., feeding, gunshot) (Geraci & Lounsbury, 2005; Dierauf & Gulland, 2001), 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; Zellar et al., 2017). 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, 2016k). 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. An in-depth discussion of strandings is in the Navy's Technical Report on Marine Mammal Strandings Associated with U.S. Navy Sonar Activities (U.S. Department of the Navy, 2017b).

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, 2017b). 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 possible indirect cause of death of the marine mammals (Cox et al., 2006). 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 reviewed training requirements, standard operating procedures, and potential mitigation measures and implemented changes to avoid or reduce the potential for acoustic-related strandings to occur in the future. Discussions of the mitigation measures associated with these and other training and testing events are presented in Chapter 5 (Mitigation).

Multiple hypotheses regarding the relationship between non-impulsive sound exposure and stranding have been proposed. 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 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.

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 our understanding of the causes of strandings (Carretta et al., 2016a). For additional information on stranding please see the technical report entitled *Marine Mammal Standings Associated with U.S. Navy Sonar Activities* (U.S. Department of the Navy, 2017b).

Data were gathered from stranding networks that operate within and adjacent to the HSTT Study Area and reviewed in an attempt to better understand the frequency that marine mammal strandings occur and what major causes of stranding's (both human-related and natural) exist in areas around the HSTT Study Area (National Marine Fisheries Service, 2015d). From 2010 through 2014, there were 314 cetacean and phocid strandings reported in Hawaii, an annual average of 63 strandings per year. Twenty-seven species stranded in this region. The most common species reported include the Hawaiian monk seal, humpback whale, sperm whale, striped and spinner dolphin. Although many marine mammals strand due to natural or anthropogenic causes, the majority of reported type of occurrences in marine mammal strandings in the Study Area include fisheries interactions, entanglement, vessel strike and predation. Bradford and Lyman (2015) address overall threats from human activities and industries on stocks in Hawaii.

In 2004, a mass out-of-habitat aggregation of melon-headed whales occurred in Hanalei Bay. It is speculated that sonar operated during a major training exercise may be related to the incident. Upon further investigation, sonar was only considered as a plausible, but not sole, contributing factor among many factors in the event. The Hanalei Bay incident does not share the characteristics observed with other mass strandings of whales coincident with sonar activity (e.g., specific traumas, species composition, etc.) (Southall et al., 2006; U.S. Department of the Navy, 2017b). 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, 2017b). In addition, on October 31, 2017, at least five pilot whales live-stranded in Nawiliwili Harbor on Kauai. NMFS has yet to determine a cause for that stranding, but Navy activities can be dismissed from consideration given there were no Navy training or testing stressors present in the area before or during the stranding (National Marine Fisheries Service, 2017b).

Records for strandings in San Diego County (covering the shoreline for the Southern California portion of the HSTT Study Area) indicate that there were 143 cetacean and 1,235 pinniped strandings between 2010 and 2014, an annual average of about 29 and 247 per year, respectively. A total of 16 different species have been reported as stranded within this time frame. The majority of species reported include long-beaked common dolphins and California sea lions, but there were also reports of pacific white-sided, bottlenose and Risso's dolphins, gray, humpback, and fin whales, harbor seals and Northern elephant seals (National Marine Fisheries Service, 2015b, 2016i). However, stranded marine mammals are reported along the entire western coast of the United States each year. Within the same timeframe, there were 714 cetacean and 11,132 pinniped strandings reported outside of the Study Area, an annual average of about 142 and 2,226 respectively. Species that strand along the entire West Coast are similar to those that typically strand within the Study Area with additional reports of harbor porpoise, Dall's porpoise, Steller sea lions, and various fur seals. The most common reported type of occurrence in stranded marine mammals in this region include fishery interactions, illness, predation, and vessel strikes (National Marine Fisheries Service, 2016i). 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). Carretta et al. (2013b; 2016b) 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.

3.7.3.1.1.7 Long-Term Consequences

Long-term consequences to a population are determined by examining changes in the population growth rate (see Figure 3.0-16). 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 measureable cost to the individual, or for very small populations to the population as a whole (e.g., Hawaiian monk seals); 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 (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 7 years apart (Falcone et al., 2009; Falcone & Schorr, 2014). 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 on 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 systems, 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; New et al., 2013a; New et al., 2013b; New et al., 2014). 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. 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 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.

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.

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. 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). 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 has 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 the 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 the Southern California Offshore Range. 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.

3.7.3.1.2 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 3.0.3.3.1 (Acoustic Stressors).

Sonar induced acoustic resonance and bubble formation phenomena are very unlikely to occur under realistic conditions, as discussed in Section 3.7.3.1.1.1 (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 3.7.3.1.1.2, Hearing Loss; 3.7.3.1.1.3, Physiological Stress; 3.7.3.1.1.4, Masking; and 3.7.3.1.1.5, Behavioral Reactions).

3.7.3.1.2.1 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 sea turtles and marine mammals uses the Navy Acoustic Effects Model to produce initial estimates of the number of animals that 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 the following:

- criteria and thresholds used to predict impacts from sonar and other transducers (see below)
- the density and spatial distribution of marine mammals
- 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>Criteria and Thresholds Used to Estimate Impacts from Sonar and Other Transducers</u>

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.

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 3.7-6). 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.

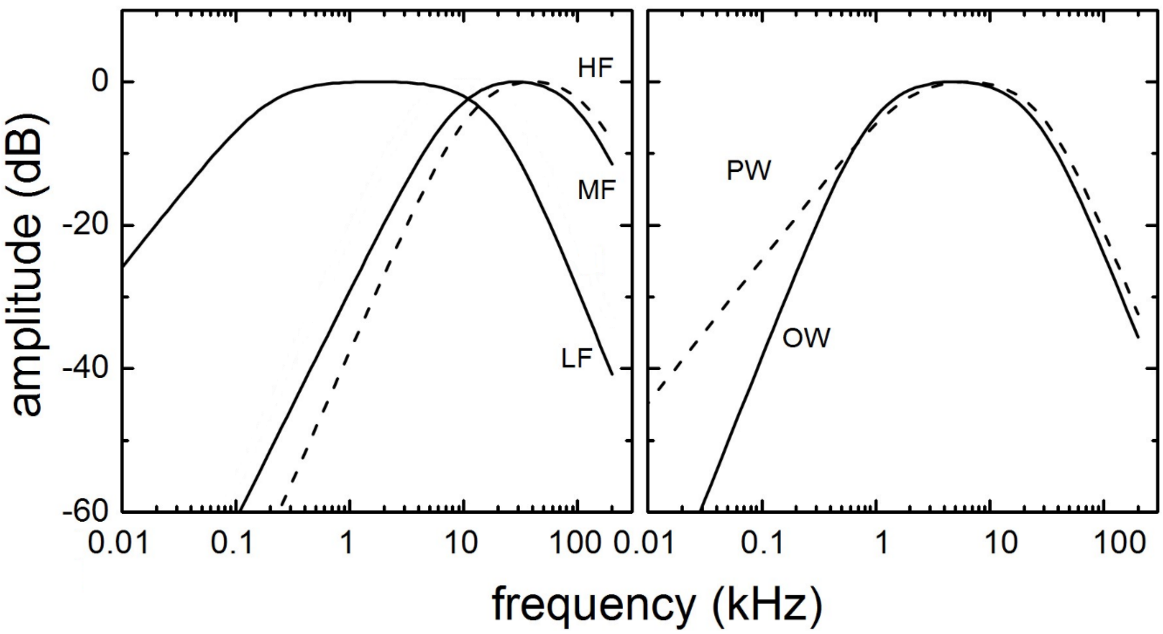


Figure 3.7-6: Navy Auditory Weighting Functions for all Species Groups

Notes: HF = High-Frequency Cetacean, LF = Low-Frequency Cetacean, MF = Mid-Frequency Cetacean, PW = Phocid (In-water), and OW = Otariid (In-water). For parameters used to generate the functions and more information on weighting function derivation see U.S. Department of the Navy (2017a)

Hearing Loss from Sonar and Other Transducers

Defining the TTS and PTS exposure functions (Figure 3.7-7) requires identifying the weighted exposures necessary for TTS and PTS onset from sounds produced by sonar and other transducers. The criteria used to define threshold shifts from non-impulsive sources (e.g., sonar) determines TTS onset as the SEL necessary to induce 6 dB of threshold shift. 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).

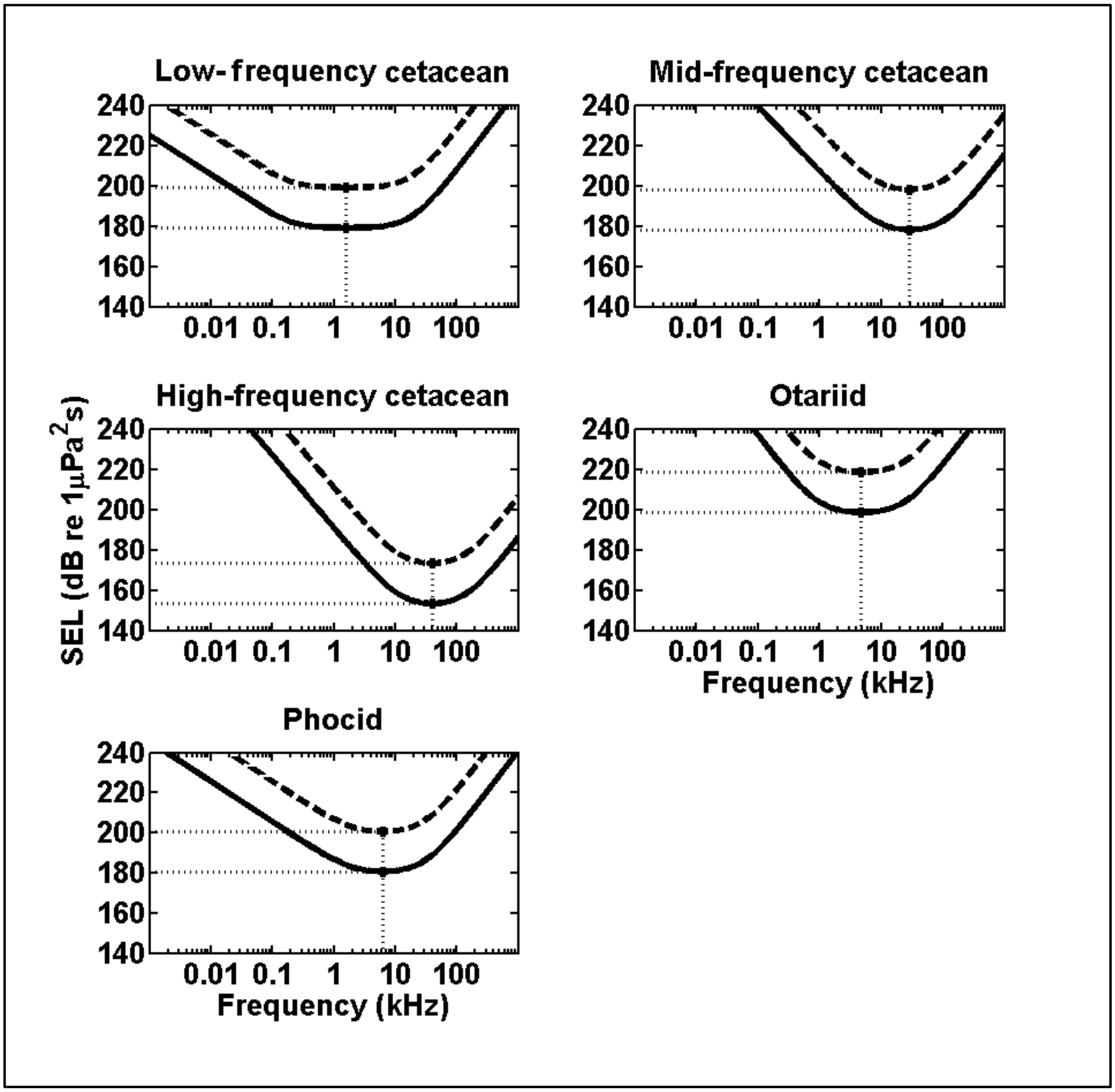


Figure 3.7-7: TTS and PTS Exposure Functions for Sonar and Other Transducers

Note: 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.

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 (U.S. Department of the Navy, 2017a) for detailed information on how the Behavioral Response Functions were derived. 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)). The likelihood of injury due to disruption of normal behaviors would depend on many factors, such as the duration of the response, what the animal is being diverted from, 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 has 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 a few 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
- avoidance of 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 3.7-8 through Figure 3.7-11). 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.

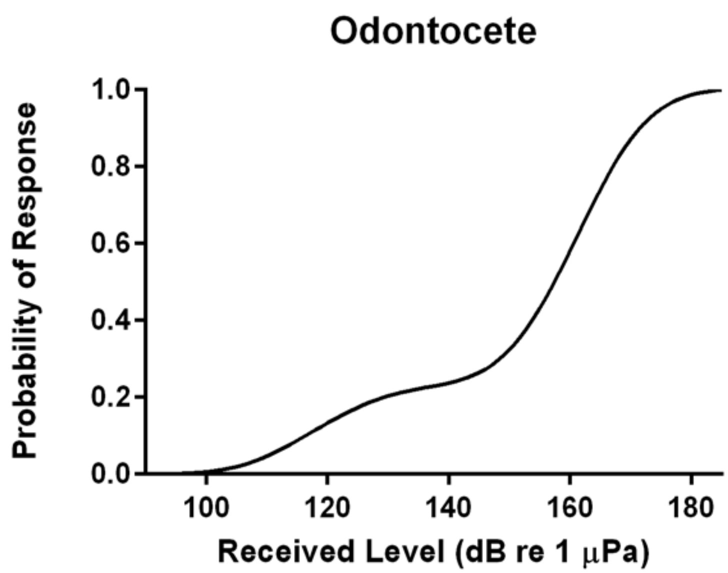


Figure 3.7-8: Behavioral Response Function for Odontocetes

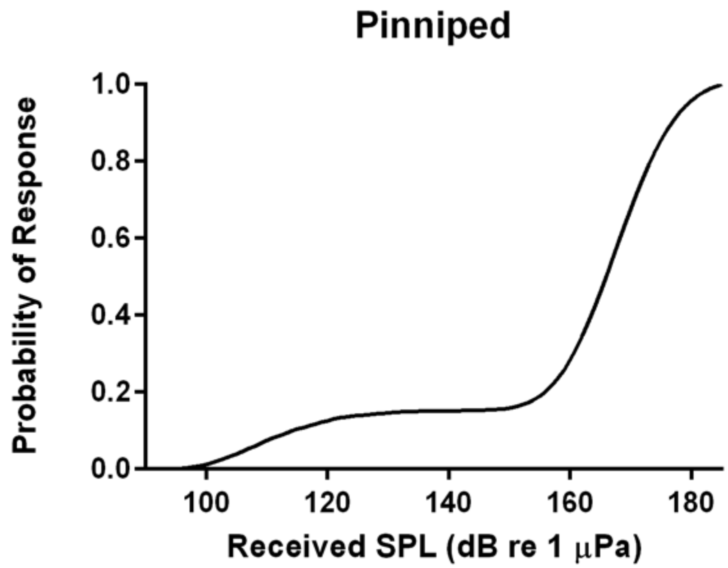


Figure 3.7-9: Behavioral Response Function for Pinnipeds

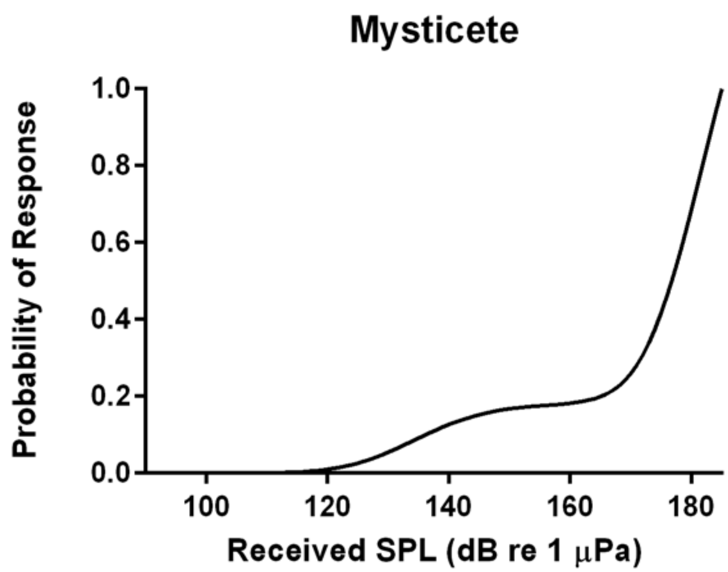


Figure 3.7-10: Behavioral Response Function for Mysticetes

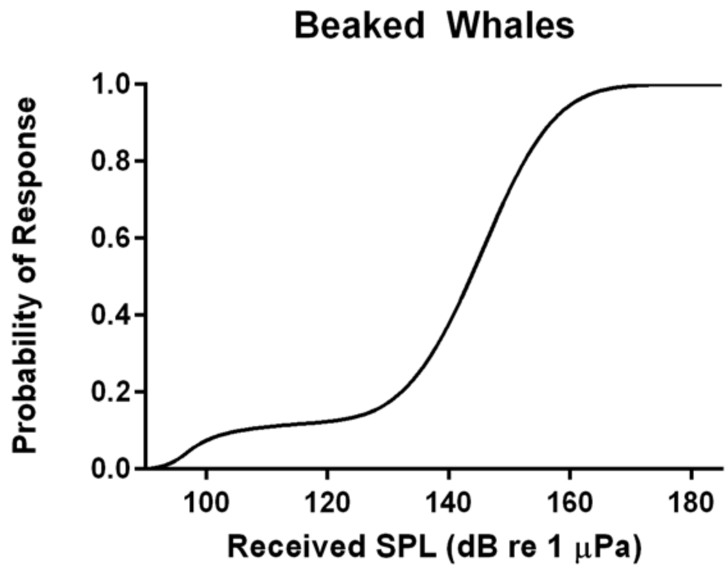


Figure 3.7-11: Behavioral Response Function for Beaked Whales

For all taxa, 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 3.7-3). 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 training and testing events that contain multiple platforms or tactical sonar sources that exceed 215 dB re 1 µPa @ 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 further ranges for these more intense activities.

Table 3.7-3: 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	5 km	10 km
Mysticetes	10 km	20 km
Beaked Whales	25 km	50 km

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 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, 2017a), 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. Activities that occur on Navy instrumented ranges or within Navy homeports require special consideration due to the repeated nature of activities in these areas.

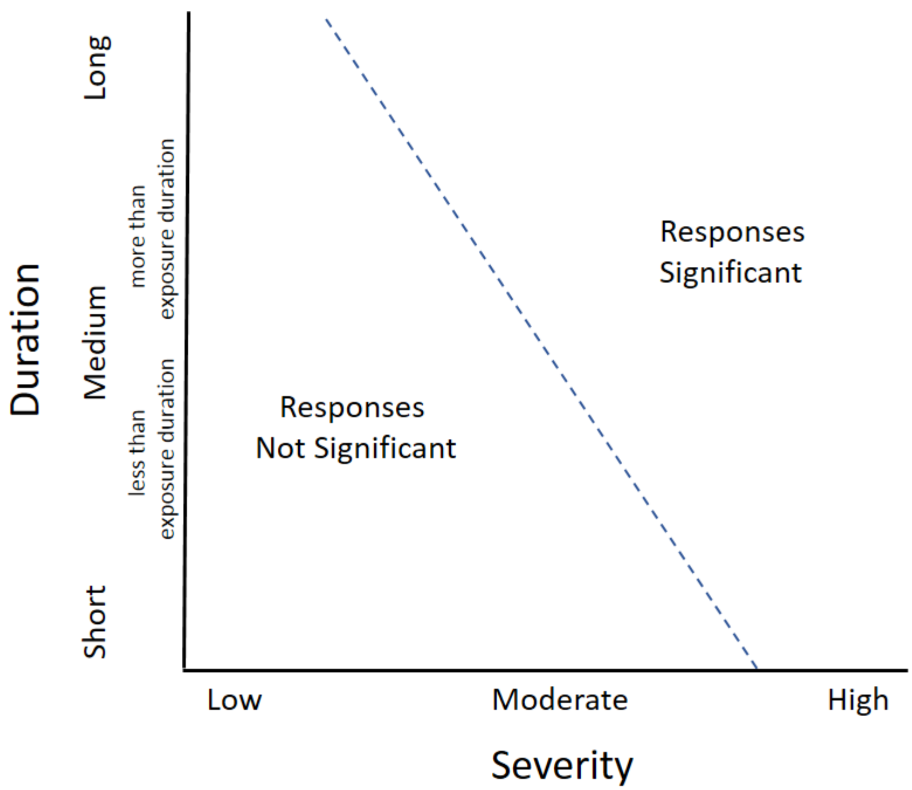


Figure 3.7-12: Relative Likelihood of a Response Being Significant Based on the Duration and Severity of Behavioral Reactions

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 3.7-12).

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 3.7.3.1.1.6, Stranding), but the confluence of factors that contributed to those strandings (i.e., constricted landmasses causing channel with little ingress/egress, multiple MFA ships in vicinity) 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.

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, 2017a), 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 quantifies 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*.

In the quantitative analysis, consideration of mitigation measures means that, for activities that implement mitigation, some model-estimated PTS is considered mitigated to the level of TTS. The impact analysis does not analyze 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. For example, based on small boat surveys between 2000 and 2012 in the Hawaiian Islands, pantropical spotted dolphins and striped dolphins were frequently observed leaping out of the water and Cuvier's beaked whales (Baird, 2013a) and Blainville's beaked whales (HDR, 2012) were occasionally observed breaching. These behaviors are visible from a great distance and likely increase sighting distances and detections of these species. Environmental conditions under which the training or testing activity could take place are also considered such as the sea surface conditions, weather (e.g., fog or rain), and day versus night.

The Navy also implements mitigation measures for certain active sonar activities within mitigation areas, as described in Section 5.4 (Mitigation Areas to be Implemented). The benefits of mitigation areas are discussed qualitatively and have not been factored into the quantitative analysis process or reductions in take for the MMPA and ESA impact estimates. Mitigation areas are designed to help avoid or reduce impacts during biologically important life processes within particularly important habitat areas. Therefore, mitigation area benefits are discussed 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.

3.7.3.1.2.2 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 be mitigated within applicable mitigation zones.

The ranges to the PTS threshold for an exposure of 30 seconds are shown in Table 3.7-4 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 meters 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. 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 181 m. PTS ranges for all other functional hearing groups, besides high-frequency cetaceans, are much shorter. 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 all other functional hearing groups (low-frequency cetaceans, mid-frequency cetaceans, phocid, seals, and otariids), 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 Navy 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.

The tables below illustrate the range to TTS for 1, 30, 60, and 120 seconds from five representative sonar systems (see Table 3.7-5 through Table 3.7-9). 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 onset-TTS.

Table 3.7-4: Range to Permanent Threshold Shift for Five Representative Sonar Systems

Hearing Group	*Approximate PTS (30 seconds) Ranges (meters)*[1]				
	Sonar bin LF5 (Low-Frequency Sources <180 dB Source level)	*Sonar bin MF1 (e.g., SQS-53 ASW Hull Mounted Sonar)*	*Sonar bin MF4 (e.g., AQS-22 ASW Dipping Sonar)*	*Sonar bin MF5 (e.g., SSQ-62 ASW Sonobuoy)*	*Sonar bin HF4 (e.g., SQS-20 Mine Hunting Sonar)*
Low-frequency Cetacean	0 (0–0)	65 (65–65)	14 (0–15)	0 (0–0)	0 (0–0)
Mid-frequency Cetacean	0 (0–0)	16 (16–16)	3 (3–3)	0 (0–0)	1 (0–2)
High-frequency Cetacean	0 (0–0)	181 (180–190)	30 (30–30)	9 (8–10)	30 (8–80)
Otariids	0 (0–0)	6 (6–6)	0 (0–0)	0 (0–0)	0 (0–0)
Phocids	0 (0–0)	45 (45–45)	11 (11–11)	0 (0–0)	0 (0–0)

[1] PTS ranges extend from the sonar or other transducers 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 parentheses.

Table 3.7-5: Ranges to Temporary Threshold Shift for Sonar Bin LF5 over a Representative Range of Environments within the Study Area

Functional Hearing Group	*Approximate TTS Ranges (meters)*[1]			
	Sonar Bin LF5 (Low-Frequency Sources <180 dB Source Level)			
	1 sec	*30 sec*	*60 sec*	*120 sec*
Low-frequency Cetacean	3 (0–4)	3 (0–4)	3 (0–4)	3 (0–4)
Mid-frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
High-frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Otariids	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Phocids	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)

[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 parentheses.

Table 3.7-6: Ranges to Temporary Threshold Shift for Sonar Bin MF1 over a Representative Range of Environments within the Study Area

Functional Hearing Group	*Approximate TTS Ranges (meters)*[1] *Sonar Bin MF1 (e.g., SQS-53 ASW Hull Mounted Sonar)*			
	1 second	***30 seconds***	***60 seconds***	***120 seconds***
Low-frequency Cetacean	903 (850–1,025)	903 (850–1,025)	1,264 (1,025–2,275)	1,839 (1,275–3,025)
Mid-frequency Cetacean	210 (210–210)	210 (210–210)	302 (300–310)	379 (370–390)
High-frequency Cetacean	3,043 (1,525–4,775)	3,043 (1,525–4,775)	4,739 (2,025–6,275)	5,614 (2,025–7,525)
Otariids	65 (65–65)	65 (65–65)	106 (100–110)	137 (130–140)
Phocids	669 (650–725)	669 (650–725)	970 (900–1,025)	1,075 (1,025–1,525)

[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 parentheses.
Note: Ranges for 1-sec and 30-sec periods are identical for Bin MF1 because this system nominally pings every 50 seconds; therefore, these periods encompass only a single ping.

Table 3.7-7: Ranges to Temporary Threshold Shift for Sonar Bin MF4 over a Representative Range of Environments within the Study Area

Functional Hearing Group	*Approximate TTS Ranges (meters)*[1] *Sonar Bin MF4 (e.g., AQS-22 ASW Dipping Sonar)*			
	1 second	***30 seconds***	***60 seconds***	***120 seconds***
Low-frequency Cetacean	77 (0–85)	162 (150–180)	235 (220–290)	370 (310–600)
Mid-frequency Cetacean	22 (22–22)	35 (35–35)	49 (45–50)	70 (70–70)
High-frequency Cetacean	240 (220–300)	492 (440–775)	668 (550–1,025)	983 (825–2,025)
Otariids	8 (8–8)	15 (15–15)	19 (19–19)	25 (25–25)
Phocids	65 (65–65)	110 (110–110)	156 (150–170)	269 (240–460)

[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 parentheses.

Table 3.7-8: Ranges to Temporary Threshold Shift for Sonar Bin MF5 over a Representative Range of Environments within the Study Area

Functional Hearing Group	*Approximate TTS Ranges (meters)*[1]			
	Sonar Bin MF5 (e.g., SSQ-62 ASW Sonobuoy)			
	1 second	*30 seconds*	*60 seconds*	*120 seconds*
Low-frequency Cetacean	10 (0–12)	10 (0–12)	14 (0–18)	21 (0–25)
Mid-frequency Cetacean	6 (0–9)	6 (0–9)	12 (0–13)	17 (0–21)
High-frequency Cetacean	118 (100–170)	118 (100–170)	179 (150–480)	273 (210–700)
Otariids	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Phocids	9 (8–10)	9 (8–10)	14 (14–16)	21 (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 parentheses

Table 3.7-9: Ranges to Temporary Threshold Shift for Sonar Bin HF4 over a Representative Range of Environments within the Study Area

Functional Hearing Group	*Approximate TTS Ranges (meters)*[1]			
	Sonar Bin HF4 (e.g., SQS-20 Mine Hunting Sonar)			
	1 second	*30 seconds*	*60 seconds*	*120 seconds*
Low-frequency Cetacean	1 (0–3)	2 (0–5)	4 (0–7)	6 (0–11)
Mid-frequency Cetacean	10 (4–17)	17 (6–35)	24 (7–60)	34 (9–90)
High-frequency Cetacean	168 (25–550)	280 (55–775)	371 (80–1,275)	470 (100–1,525)
Otariids	0 (0–0)	0 (0–0)	0 (0–0)	1 (0–1)
Phocids	2 (0–5)	5 (2–8)	8 (3–13)	11 (4–22)

[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 parentheses.

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 3.7-10 through Table 3.7-14, respectively. See Section 3.7.3.1.2.1 (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 3.7-10: Ranges to a Potentially Significant Behavioral Response for Sonar Bin LF5 over a Representative Range of Environments within the Study Area

Received Level (dB re 1 µPa)	*Minimum and Maximum Range (m)*	*Probability of Behavioral Response*			
		Odontocete	*Mysticete*	*Pinniped*	*Beaked Whale*
178	1 (1–1)	97%	59%	92%	100%
172	2 (1–2)	91%	30%	76%	99%
166	3 (1–5)	78%	20%	48%	97%
160	7 (1–13)	58%	18%	27%	93%
154	16 (1–30)	40%	17%	18%	83%
148	35 (1–85)	29%	16%	16%	66%
142	81 (1–230)	25%	13%	15%	45%
136	183 (1–725)	23%	9%	15%	28%
130	404 (1–1,525)	20%	5%	15%	18%
124	886 (1–3,025)	17%	2%	14%	14%
118	1,973 (725–5,775)	12%	1%	13%	12%
112	4,472 (900–18,275)	6%	0%	9%	11%
106	8,936 (900–54,525)	3%	0%	5%	11%
100	27,580 (900–88,775)	1%	0%	2%	8%

dB re 1 µPa= decibels referenced to 1 micropascal; m= meters
Note: 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 3.7-3 for behavioral cut-off distances).

Table 3.7-11: 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)	*Minimum and Maximum Range (m)*	*Probability of Behavioral Response*			
		Odontocete	*Mysticete*	*Pinniped*	*Beaked Whale*
196	109 (100–110)	100%	100%	100%	100%
190	239 (190–250)	100%	98%	99%	100%
184	502 (310–575)	99%	88%	98%	100%
178	1,024 (550–2,025)	97%	59%	92%	100%
172	2,948 (625–5,775)	91%	30%	76%	99%
166	6,247 (625–10,025)	78%	20%	48%	97%
160	11,919 (650–20,525)	58%	18%	27%	93%
154	20,470 (650–62,025)	40%	17%	18%	83%
148	33,048 (725–63,525)	29%	16%	16%	66%
142	43,297 (2,025–71,775)	25%	13%	15%	45%
136	52,912 (2,275–91,525)	23%	9%	15%	28%
130	61,974 (2,275–100,000*)	20%	5%	15%	18%
124	66,546 (2,275–100,000*)	17%	2%	14%	14%
118	69,637 (2,525–100,000*)	12%	1%	13%	12%
112	73,010 (2,525–100,000*)	6%	0%	9%	11%
106	75,928 (2,525–100,000*)	3%	0%	5%	11%
100	78,899 (2,525–100,000*)	1%	0%	2%	8%

dB re 1 µPa= decibels referenced to 1 micropascal; m= meters
* Indicates maximum range to which acoustic model was run, a distance of approximately 100 kilometers from the sound source.
Note: 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 3.7-3 for behavioral cut-off distances).

Table 3.7-12: 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)	*Minimum and Maximum Range (m)*	*Probability of Behavioral Response for Sonar Bin MF4*			
		Odontocete	*Mysticete*	*Pinniped*	*Beaked Whale*
196	8 (1–8)	100%	100%	100%	100%
190	17 (1–17)	100%	98%	99%	100%
184	34 (1–35)	99%	88%	98%	100%
178	68 (1–75)	97%	59%	92%	100%
172	145 (130–300)	91%	30%	76%	99%
166	388 (270–875)	78%	20%	48%	97%
160	841 (470–1,775)	58%	18%	27%	93%
154	1,748 (700–6,025)	40%	17%	18%	83%
148	3,163 (1,025–13,775)	29%	16%	16%	66%
142	5,564 (1,275–27,025)	25%	13%	15%	45%
136	8,043 (1,525–54,275)	23%	9%	15%	28%
130	17,486 (1,525–65,525)	20%	5%	15%	18%
124	27,276 (1,525–84,775)	17%	2%	14%	14%
118	33,138 (2,775–85,275)	12%	1%	13%	12%
112	39,864 (3,775–100,000*)	6%	0%	9%	11%
106	45,477 (5,275–100,000*)	3%	0%	5%	11%
100	48,712 (5,275–100,000*)	1%	0%	2%	8%

dB re 1 µPa= decibels referenced to 1 micropascal; m= meters
* Indicates maximum range to which acoustic model was run, a distance of approximately 100 kilometers from the sound source.
Note: 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 3.7-3 for behavioral cut-off distances).

Table 3.7-13: 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)	*Minimum and Maximum Range (m)*	*Probability of Behavioral Response for Sonar Bin MF5*			
		Odontocete	*Mysticete*	*Pinniped*	*Beaked Whale*
196	0 (0–0)	100%	100%	100%	100%
190	2 (1–3)	100%	98%	99%	100%
184	4 (1–7)	99%	88%	98%	100%
178	14 (1–15)	97%	59%	92%	100%
172	29 (1–30)	91%	30%	76%	99%
166	59 (1–70)	78%	20%	48%	97%
160	133 (1–340)	58%	18%	27%	93%
154	309 (1–950)	40%	17%	18%	83%
148	688 (430–2,275)	29%	16%	16%	66%
142	1,471 (650–4,025)	25%	13%	15%	45%
136	2,946 (700–7,525)	23%	9%	15%	28%
130	5,078 (725–11,775)	20%	5%	15%	18%
124	7,556 (725–19,525)	17%	2%	14%	14%
118	10,183 (725–27,775)	12%	1%	13%	12%
112	13,053 (725–63,025)	6%	0%	9%	11%
106	16,283 (1,025–64,525)	3%	0%	5%	11%
100	20,174 (1,025–70,525)	1%	0%	2%	8%

dB re 1 µPa= decibels referenced to 1 micropascal; m= meters

Note: 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 3.7-3 for behavioral cut-off distances).

Table 3.7-14: 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)	Minimum and Maximum Range (m)	Probability of Behavioral Response for Sonar Bin HF4			
		Odontocete	Mysticete	Pinniped	Beaked Whale
196	3 (1–6)	100%	100%	100%	100%
190	8 (1–16)	100%	98%	99%	100%
184	17 (1–35)	99%	88%	98%	100%
178	34 (1–90)	97%	59%	92%	100%
172	68 (1–180)	91%	30%	76%	99%
166	133 (12–430)	78%	20%	48%	97%
160	255 (30–750)	58%	18%	27%	93%
154	439 (50–1,525)	40%	17%	18%	83%
148	694 (85–2,275)	29%	16%	16%	66%
142	989 (110–3,525)	25%	13%	15%	45%
136	1,378 (170–4,775)	23%	9%	15%	28%
130	1,792 (270–6,025)	20%	5%	15%	18%
124	2,259 (320–7,525)	17%	2%	14%	14%
118	2,832 (320–8,525)	12%	1%	13%	12%
112	3,365 (320–10,525)	6%	0%	9%	11%
106	3,935 (320–12,275)	3%	0%	5%	11%
100	4,546 (320–16,775)	1%	0%	2%	8%

Note: dB re 1 µPa = decibels referenced to 1 micropascal; m = meters

3.7.3.1.2.3 Impacts from Sonar and Other Transducers Under the Action Alternatives

Sonar and other transducers emit sound waves into the water to detect objects, safely navigate, and communicate. 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 during training under Alternative 1 and 2 are described in Section 3.0.3.3.1 (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 Activity Descriptions). The major differences between the action alternatives for the purposes of analyzing impacts on marine mammals are:

- Under Alternative 1, for training, the number of major training exercises and Civilian Port Defense activities would fluctuate annually. In addition, alternative one accounts for the portion of Unit Level Surface Ship ASW that is met during participation in other ASW exercises or through the use of synthetic trainers for very basic levels of training. Training activities using sonar and other transducers could occur throughout the Study Area, although use would generally occur within 200 NM of shore in Navy Operating Areas, on Navy range complexes, on Navy testing ranges, or around inshore locations identified in Chapter 2 (Description of Proposed Action and Alternatives).
- Under Alternative 1, for testing, the number of testing activities would fluctuate annually. Testing activities using sonar and other transducers could occur throughout the Study Area,

although use would generally occur within Navy range complexes, on Navy testing ranges, or around inshore locations identified in Chapter 2 (Description of Proposed Action and Alternatives).

- Under Alternative 2, for training, the maximum number of major training exercises could occur every year and only the number of Civilian Port Defense activities would fluctuate annually. In addition, all unit level surface ship ASW training requirements would be completed through individual events conducted at sea, rather than through leveraging other ASW training exercises or the use of synthetic trainers. Training activities using sonar and other transducers could occur throughout the Study Area, although use would generally occur within 200 NM of shore in Navy Operating Areas, on Navy range complexes, on Navy testing ranges, or around inshore locations identified in Chapter 2 (Description of Proposed Action and Alternatives).
- Under Alternative 2, for testing, the maximum number of nearly all testing activities would occur every year. This would result in an increase of sonar use compared to Alternative 1. Testing activities using sonar and other transducers could occur throughout the Study Area, although use would generally occur within Navy range complexes, on Navy testing ranges, or around inshore locations identified in Chapter 2 (Description of Proposed Action and Alternatives).

Major training exercises (Composite Training Unit Exercise, Rim of the Pacific Exercise) are multi-day exercises that transition across large areas and involve multiple anti-submarine warfare assets. It is important to note that, while major training exercises focus on anti-submarine warfare, there are significant periods when active anti-submarine warfare sonars are not in use. Nevertheless, behavioral reactions are assumed more likely to be significant than during other anti-submarine warfare activities due to the duration (i.e., multiple days) and scale (i.e., multiple sonar platforms) of the major training exercises. Although major training exercises tend to move to different locations as the event unfolds, some animals could be exposed multiple times over the course of a few days.

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 than with other anti-submarine warfare activities with greater intensity and duration. Unit level training activities are more likely to occur close to homeports and in the same general locations each time, so resident animals could be more frequently exposed to these types of activities. Coordinated/integrated exercises involve multiple assets and can last for several days transiting across large areas of a range complex. Repeated exposures to some individual marine mammals are likely during coordinated/integrated exercises. However, due to the shorter duration and smaller footprint compared to major training exercises, impacts from these activities are less likely to be significant with the possible exception of resident animals near homeports or Navy instrumented ranges that may incur some repeated exposures.

Anti-submarine warfare testing activities are typically similar to unit level training. Vessel evaluation testing activities also use the same anti-submarine warfare sonars on ships and submarines. Testing activities that use anti-submarine warfare sonars typically occur in water deeper than approximately 200 m and therefore out of most nearshore habitats where productivity is typically higher (i.e., more food) and many marine mammals have higher abundances. Therefore, significant reactions to anti-submarine warfare and vessel evaluation testing activities are less likely than with larger anti-submarine warfare training activities discussed above in Impacts from *Sonar and Other Transducers Under Alternative 1 for Training Activities*. Anti-submarine warfare and vessel evaluation testing activities are more likely to occur close to homeports and testing facilities and in the same general locations each time, so resident animals could be more frequently exposed to these types of activities. 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 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.

Mine warfare testing activities typically involve a ship, helicopter, or unmanned vehicle testing a mine-hunting sonar system. Unmanned underwater vehicle testing also employs 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.

Navigation and object detection activities typically employ ship and submarine based sonar systems and other transducers to navigate and avoid underwater objects. Significant reactions in marine mammals have not been reported due to exposure to most of the sonars and other transducers typically used in these activities. Some hull-mounted anti-submarine warfare sonars (e.g., Bin MF1) have a mode to look for objects in the water such as mines, but this mode uses different source characteristics as compared to the anti-submarine warfare mode. Significant behavioral reactions have not been observed in relation to hull-mounted sonars using object-detection mode. Significant behavioral reactions have not been observed in relation to hull-mounted sonars using object-detection mode; however, significant reactions may be more likely in that mode than for all other sonar systems and transducers used within these navigation and object detection activities due to the additional presence of a moving vessel and higher source levels in that mode. Individual animals could show short-term and minor to moderate responses to these systems, although these reactions are very unlikely to lead to any costs or long-term consequences for individuals or populations.

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.

Surface warfare activities require limited use of sonar or other transducers as compared to other types of activities discussed above, typically limited to the sonar targeting system of a few torpedoes. The limited scope and duration of sonar use in these activities makes significant behavioral reactions less likely than with other activities that use anti-submarine warfare sonar systems and other transducers, which are discussed above.

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 3.7.3.1.2.1, 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 Mammals 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 3.7-13). The Activity Categories that are most likely to cause impacts and the most likely region in which impacts could occur are represented in the impact graphics for each species. There is a potential for impacts on 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.

Regions within the HSTT Study Area include (see Study Area maps Chapter 2) the Hawaii OPAREA, the Temporary Hawaii OPAREA, the SOCAL Defined Training Areas, the Western SOCAL OPAREA, and the Transit Lane. The SOCAL portion of the HSTT Study Area encompasses the SOCAL Defined Training Areas that are located within approximately 200 NM of the coast and the Western SOCAL OPAREA, which extends westward beyond 200 NM. Similarly, the Hawaii Range Complex portion of the HSTT Study Area is divided into the Hawaii OPAREA that is located around the main Hawaiian Islands within about 200 NM and the Temporary Hawaii OPAREA that extends to the northwest beyond about 200 NM.

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 3.0.3.3.1 (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 3.7.3.1.1.5, 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 3.7.3.1.2.1, 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 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 activities throughout the year, although many species are not present in the Hawaii Range Complex 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 3.7.2.1.4, 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 3.7.3.1.2 (Impacts from Sonar and Other Transducers).

A few behavioral reactions in mysticetes resulting from exposure to sonar could take place at distances of up to 20 km. Behavioral reactions, however, are much more likely 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 larger activities such as a major training exercise as it moves through an area, although these activities generally do not use the same training locations day-after-day during multi-day activities. Therefore, displaced animals could return quickly after the major training exercise finishes. It is unlikely that most mysticetes would encounter a major training exercise more than once per year. 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. 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, such as TTS (Section 3.7.3.1.1.5, 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 threshold shift. 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 3.7.3.1.1.2, 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 3.7.3.1.1.4 (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. 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 mysticetes. High-frequency (greater than 10 kHz) sonars fall outside of the best hearing and vocalization ranges of mysticetes (see Section 3.7.2.1.4, 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 a 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 3.7.2.1.4 (Hearing and Vocalization) discusses low-frequency cetacean (i.e., mysticetes) hearing abilities.

Blue Whales (Endangered Species Act-Listed)

<u>Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities</u>

Blue 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. See below Figure 3.7-13 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-15).

For mysticetes, 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area in July through October. Navy training activities that use sonar and other transducers could occur year round within the Study Area although are concentrated on Navy ranges; however, these four feeding areas make up a very small portion of the Southern California Range Complex. As discussed above, blue whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away and when the animals are engaged in important biological behaviors such as feeding. Therefore, significant impacts on blue whale feeding behaviors from training with sonar and other transducers are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1. See Figure 3.7-13 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-15).

For mysticetes, 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area in July through October. Navy testing activities that use sonar and other transducers could occur year round within the Study Area; however, these four feeding areas make up a very small portion of the Southern California Range Complex. As discussed above, blue whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away and when the animals are engaged in important biological behaviors such as feeding. Therefore, significant impacts on blue whale feeding behaviors from testing with sonar and other transducers are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

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.

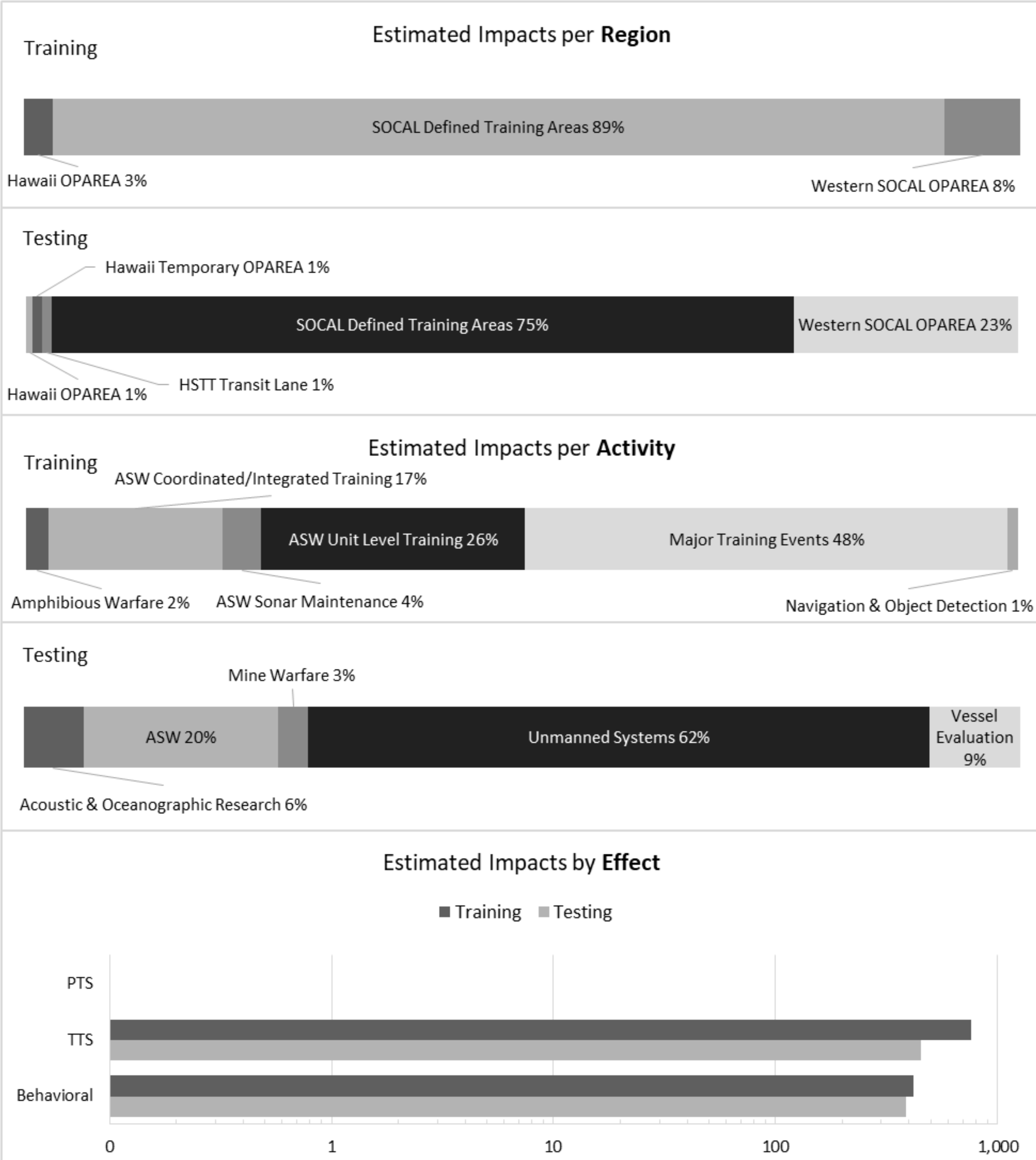


Figure 3.7-13: Blue Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-15: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
Eastern North Pacific	97%	98%
Central North Pacific	3%	2%

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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2. See Figure 3.7-14 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-16).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as Alternative 1, although the numbers of 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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2. See Figure 3.7-14 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-16).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 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.

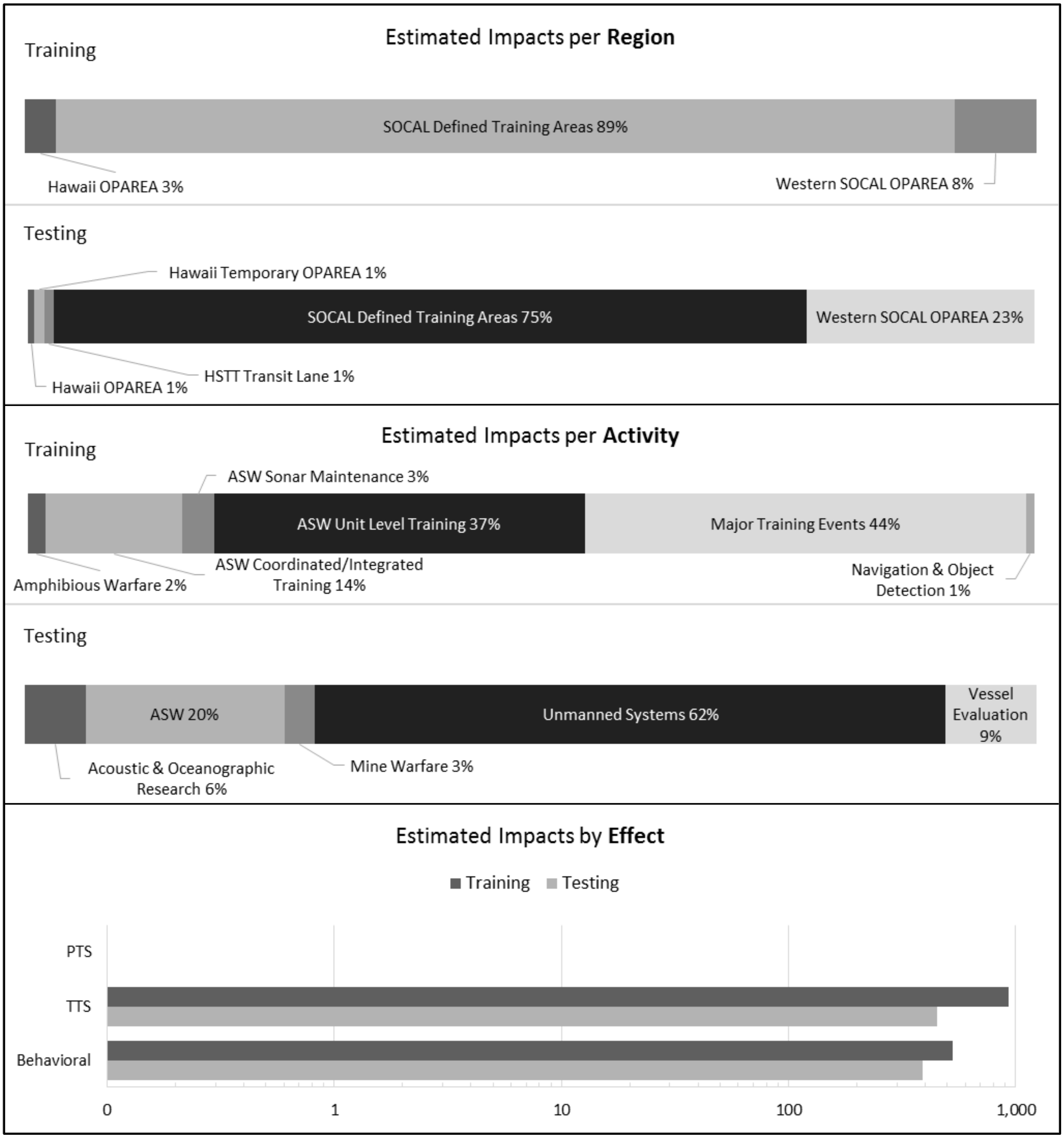


Figure 3.7-14: Blue Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-16: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
Eastern North Pacific	97%	98%
Central North Pacific	3%	2%

Bryde's Whales

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

Bryde's 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. See Figure 3.7-15 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-17).

For mysticetes, 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 will 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 Bryde's 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

Bryde's 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. See Figure 3.7-15 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-17).

For mysticetes, 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 will 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 Bryde's whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

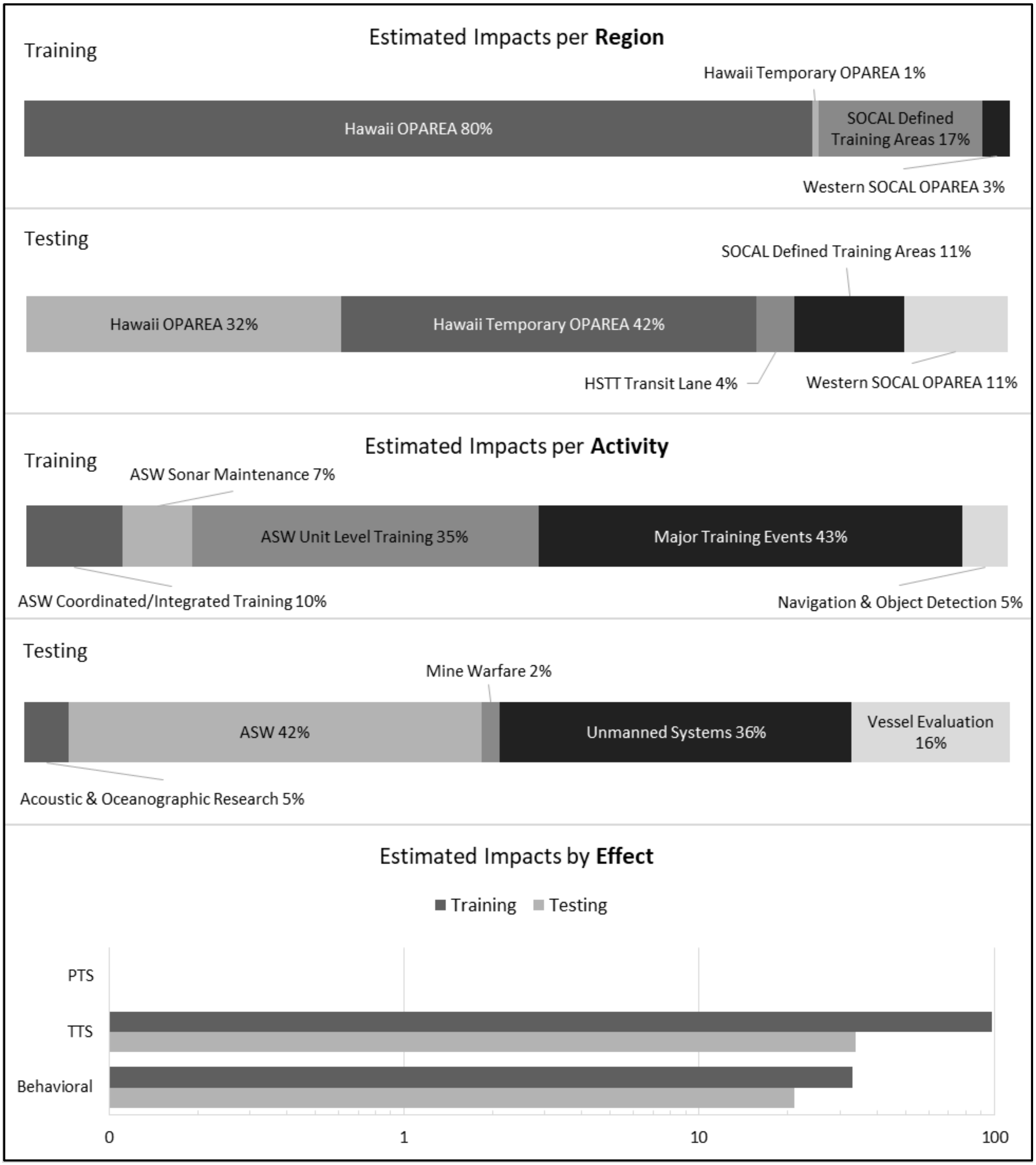


Figure 3.7-15: Bryde's Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-17: Estimated Impacts on Individual Bryde's Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	81%	74%
Eastern Tropical Pacific	19%	26%

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

Bryde's 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. See Figure 3.7-16 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-18).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 Bryde's whales incidental to those activities.

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

Bryde's 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. See Figure 3.7-16 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-18).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 Bryde's whales incidental to those activities.

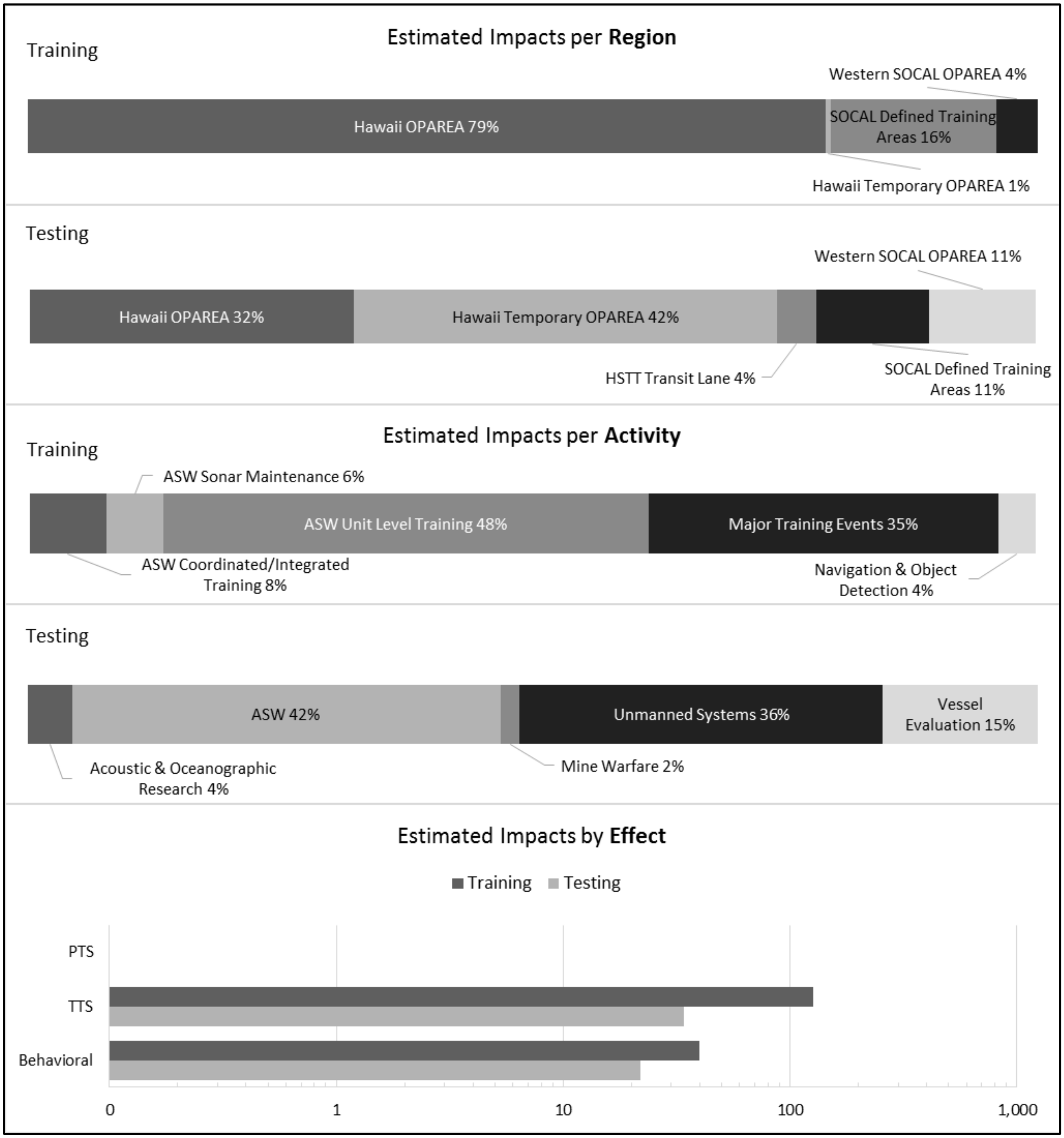


Figure 3.7-16: Bryde's Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-18: Estimated Impacts on Individual Bryde's Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	79%	74%
Eastern Tropical Pacific	21%	26%

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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1. See Figure 3.7-17 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-19).

As described for other 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 will 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 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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1. See Figure 3.7-17 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-19)

As described for other 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 will 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.

Figure 3.7-17: Fin Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-19: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	97%	98%
Hawaiian	3%	2%

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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2. See Figure 3.7-18 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-20).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2. See Figure 3.7-18 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-20).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 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.

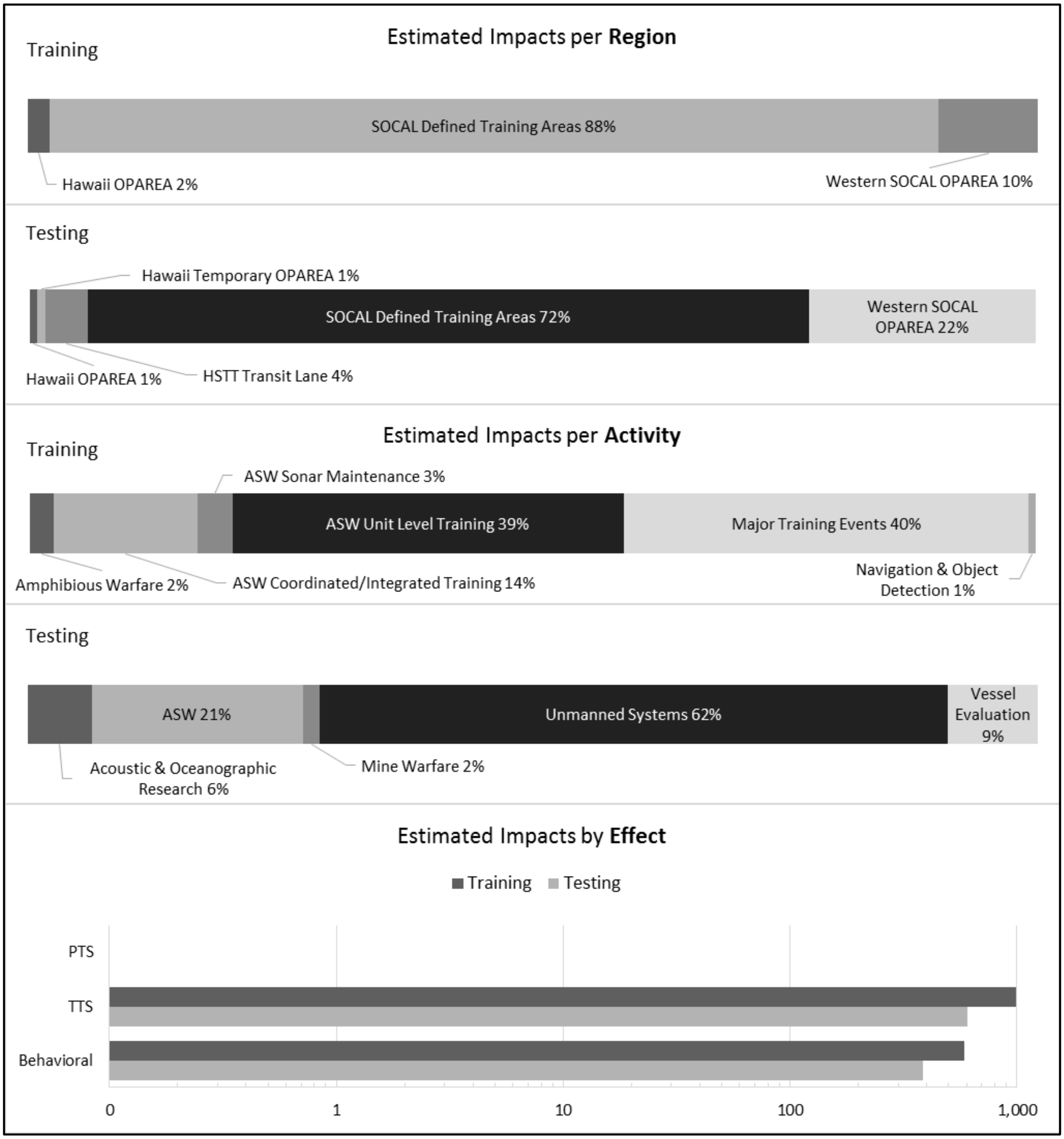


Figure 3.7-18: Fin Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-20: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	98%	98%
Hawaiian	2%	2%

Gray Whales

The vast majority of gray whales in the Study Area are from the non-endangered Eastern North Pacific stock, and all of the modeled impacts are for this stock. On very rare occasions Western North Pacific gray whales, which are Endangered Species Act-Listed, occur in the Study Area but did not have any estimated takes in this analysis.

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

Gray whales 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. See Figure 3.7-19 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Eastern North Pacific stock.

As described for other 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. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Range Complex within the Study Area. The identified areas are active altogether during the months of October through July, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Navy training activities that use sonar and other transducers could occur year round within the Study Area. As discussed above, gray whales may either pause their migration until the sound source ceases or moves, or they could route around the source by a couple of kilometers if it was directly in their migratory path. Although, as with most other mysticetes, gray whale reactions to sonar are most likely to be short-term and mild to moderate. Therefore, significant impacts on gray whale migration behaviors from training with sonar and other transducers are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015).

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 would not affect ESA-listed gray whales.

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

Gray 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 1. See Figure 3.7-19 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Eastern North Pacific stock.

As described for other 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. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Range Complex within the Study Area. The identified areas are active altogether during the months of July through March, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Navy testing activities that use sonar and other transducers could occur year round within the Study Area. As discussed above, gray whales may either pause their migration until the sound source ceases or moves, or they could route around the source by a couple of kilometers if it was directly in their migratory path. Although, as with most other mysticetes, gray whale reactions to sonar are most likely to be short-term and mild to moderate. Therefore, significant impacts on gray whale migration behaviors from testing with sonar and other transducers are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015).

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 would not affect ESA-listed gray whales.

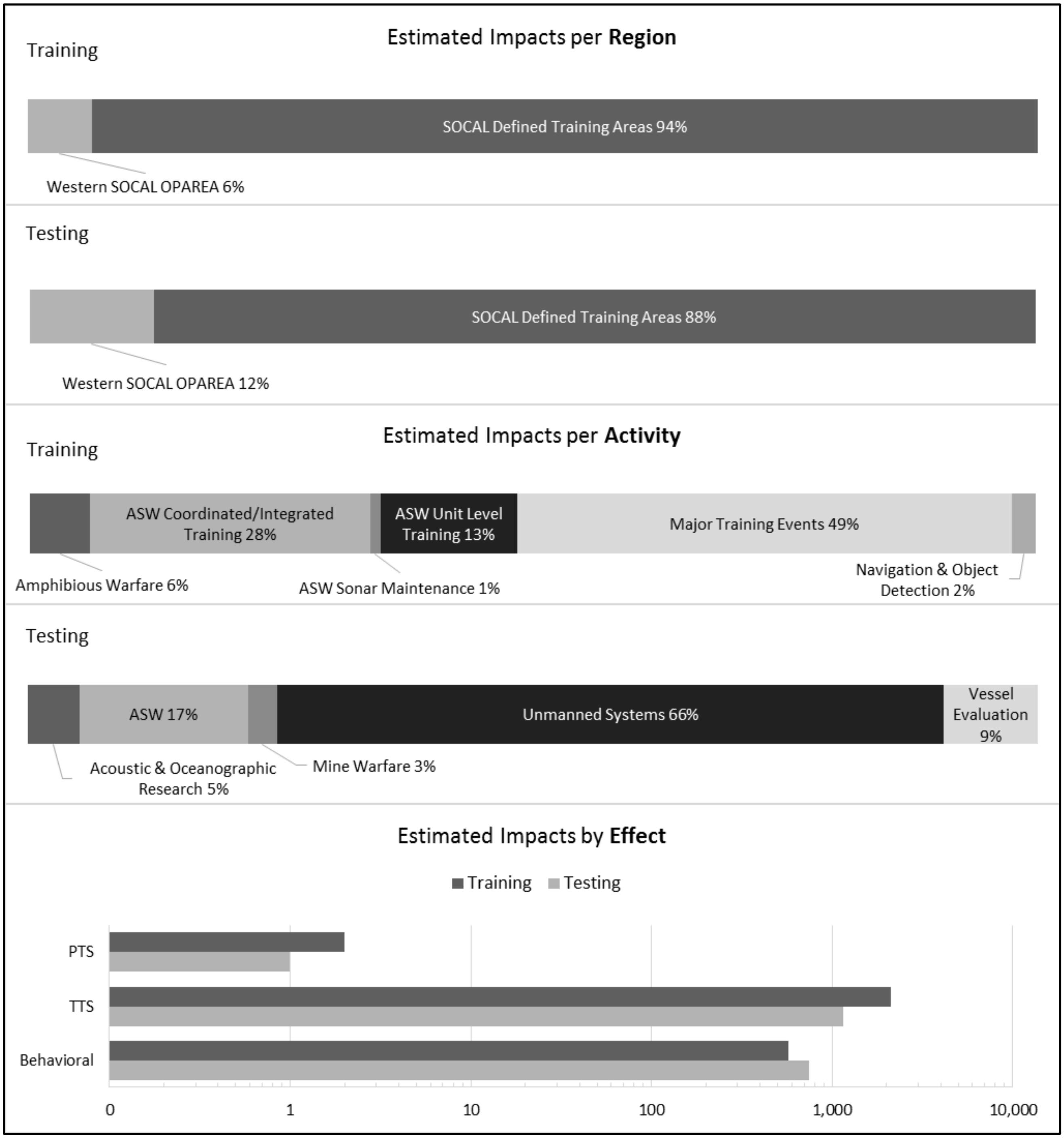


Figure 3.7-19: Gray Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent Eastern North Pacific Stock. ASW = Anti-Submarine Warfare

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

Gray whales 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. See Figure 3.7-20 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Eastern North Pacific stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 would not affect ESA-listed gray whales.

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

Gray 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. See Figure 3.7-20 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Eastern North Pacific stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 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 would not affect ESA-listed gray whales.

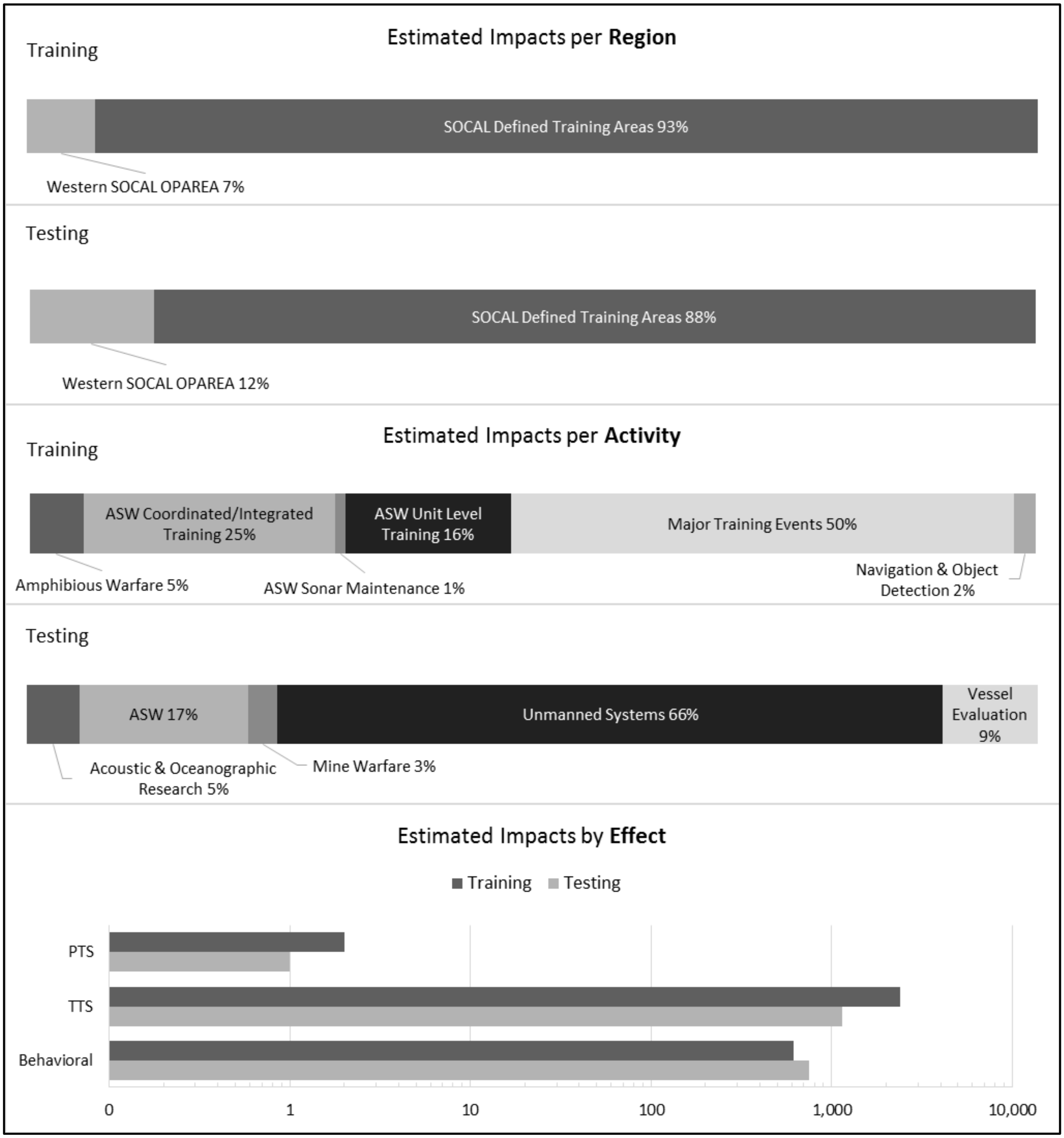


Figure 3.7-20: Gray Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent Eastern North Pacific Stock. ASW = Anti-Submarine Warfare

Humpback Whales

Impacts have been modeled for the Hawaiian population of humpback whales, which are not Endangered Species Act-Listed, and for the Mexican and Central American populations of humpback whales, which are Endangered Species Act-Listed.

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

Humpback whales 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. See Figure 3.7-21 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-21).

As described for other 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. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A seasonal reproduction area for humpback whales identified by Baird et al. (2015) overlaps the Hawaii Range Complex within the HSTT Study Area in December through April. Navy training activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified humpback whale reproduction area is mostly in shallow, near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training exercises. Sound from sonar or other transducers used outside of the area might expose animals within the identified humpback whale reproduction area identified by Baird et al. (2015). For distant sources, spreading losses in deep water, attenuation over long distances and upslope propagation with the associated bottom losses will likely reduce received levels in the reproductive areas. Some impacts on reproductive behavior could occur due to activities more proximal to the reproductive area. As discussed above, humpback whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away and when the animals are engaged in important biological behaviors. Therefore, significant impacts on humpback whale reproductive behaviors from training with sonar and other transducers are unlikely to occur within the reproduction area identified by Baird et al. (2015).

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.

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

Humpback 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 1. See Figure 3.7-21 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-21).

As described for other 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. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A seasonal reproduction area for humpback whales identified by Baird et al. (2015a) overlaps the Hawaii Range Complex within the HSTT Study Area in December through April. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified humpback whale reproduction area is mostly in shallow, near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare testing. The highest concentrations of humpback whales occur within the 4-Islands Region Mitigation Area, Humpback Whale Special Reporting Area, and Humpback Whale Awareness Notification Message Area, as discussed in Chapter 5 (Mitigation). Sound from sonar or other transducers used outside of the area might expose animals within the identified humpback whale reproduction area identified by Baird et al. (2015). Although propagation from distant sources combined with signal loss from deep-water to shallow water transition would likely mean relatively low receive levels occur within the reproductive area, some impacts on reproductive behavior could occur due to the proximity of the activities to the reproductive areas. As discussed above, humpback whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away and when the animals are engaged in important biological behaviors. Therefore, significant impacts on humpback whale reproductive behaviors from testing with sonar and other transducers are unlikely to occur within the reproduction area identified by Baird et al. (2015a).

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.

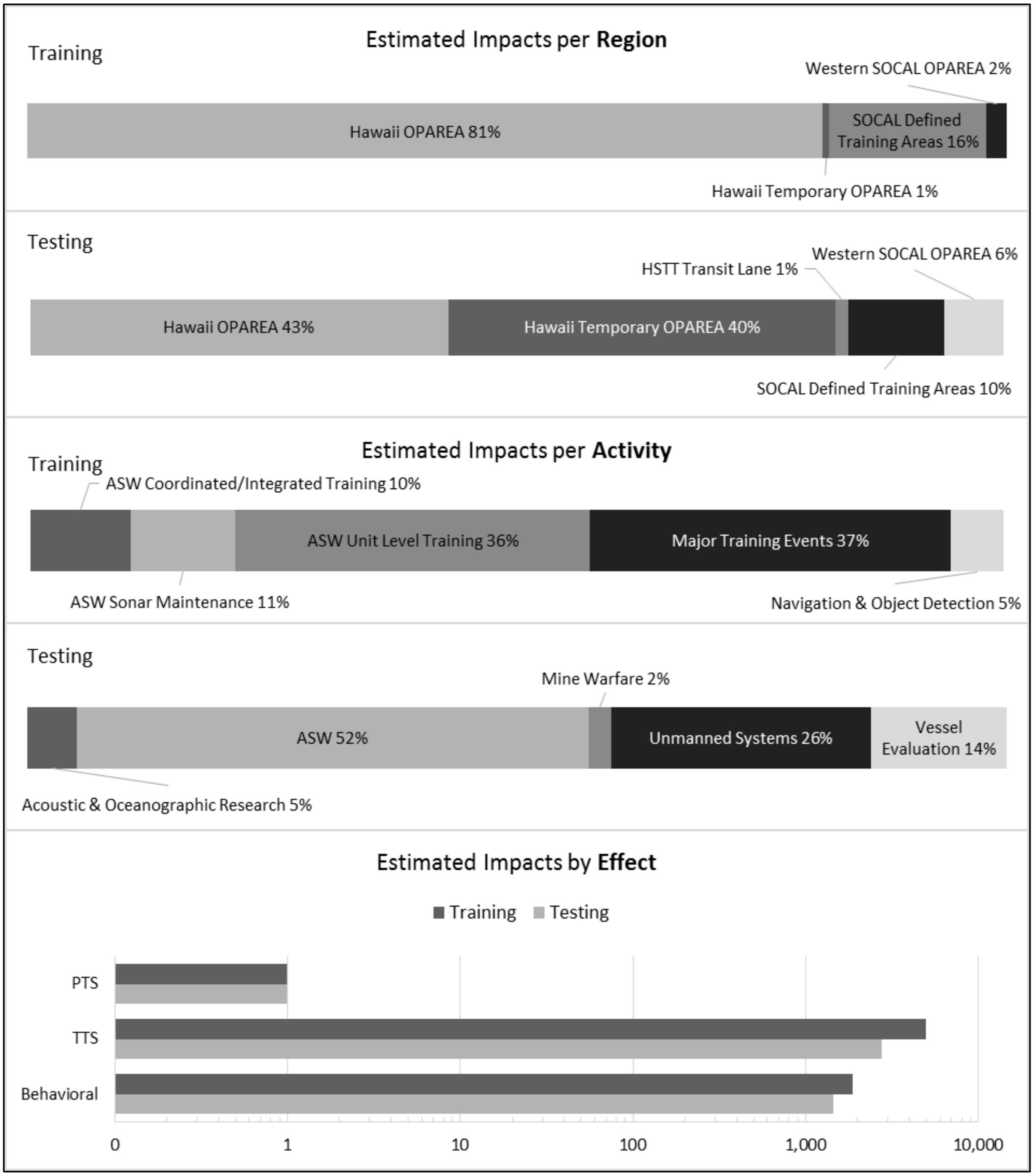


Figure 3.7-21: Humpback Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. ASW = Anti-Submarine Warfare

Table 3.7-21: 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 per **Species' DPS**		
DPS	***Training***	***Testing***
Central America DPS (California, Oregon, & Washington)	9%	7%
Mexico DPS (California, Oregon, & Washington)	10%	11%
Hawaii DPS (Central North Pacific)	82%	83%

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

Humpback whales 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. See Figure 3.7-22 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-22).

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

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.

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

Humpback 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. See Figure 3.7-22 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-22).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 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.

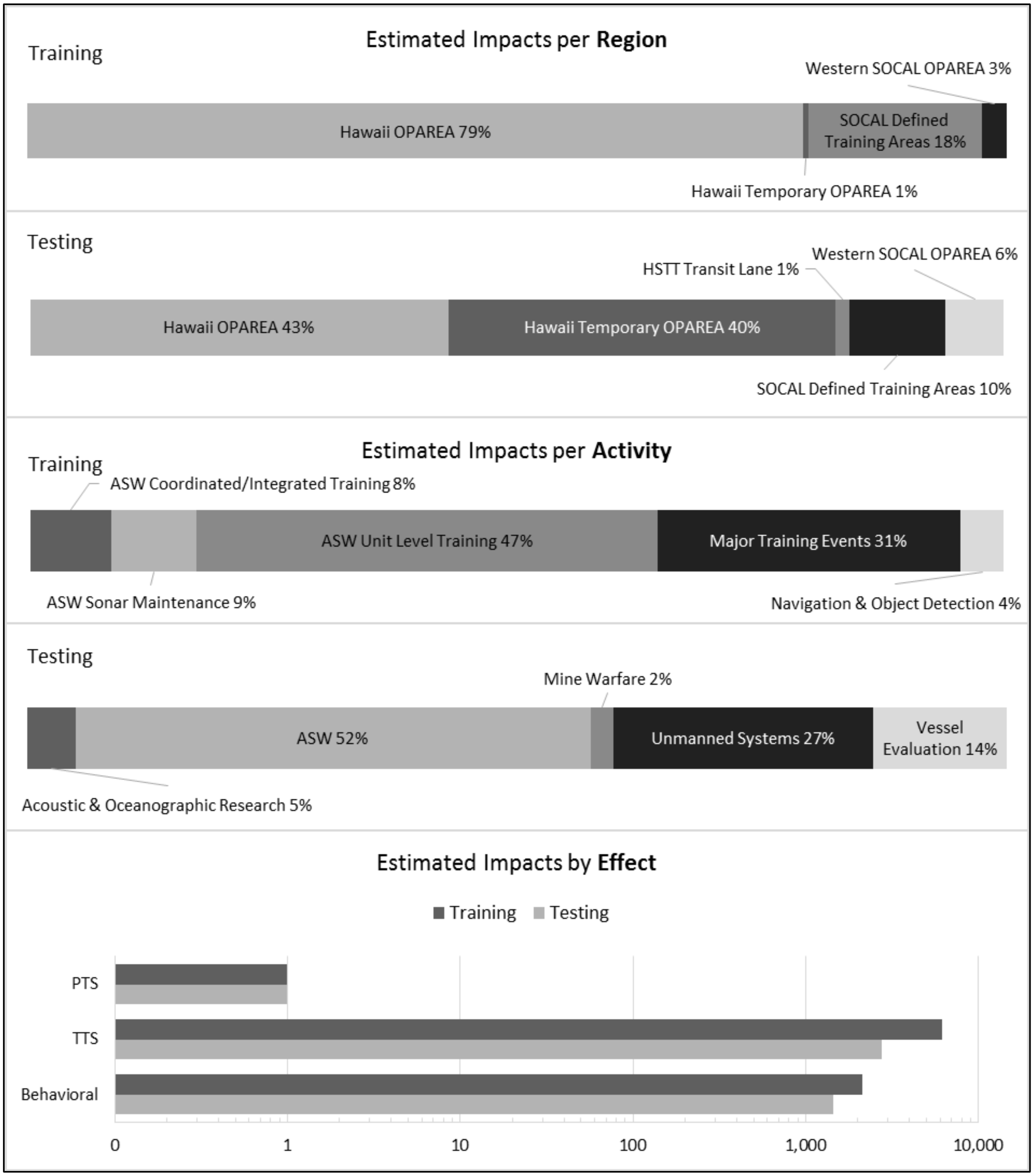


Figure 3.7-22: Humpback Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts.
ASW = Anti-Submarine Warfare

Table 3.7-22: 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 per **Species' DPS**		
DPS	***Training***	***Testing***
Central America DPS (California, Oregon, & Washington)	11%	7%
Mexico DPS (California, Oregon, & Washington)	10%	11%
Hawaii DPS (Central North Pacific)	80%	83%

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, TTS, and PTS under Alternative 1. See Figure 3.7-23 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-23).

As described for other 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. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. 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 will 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 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. See Figure 3.7-23 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-23).

As described for other 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 will 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.

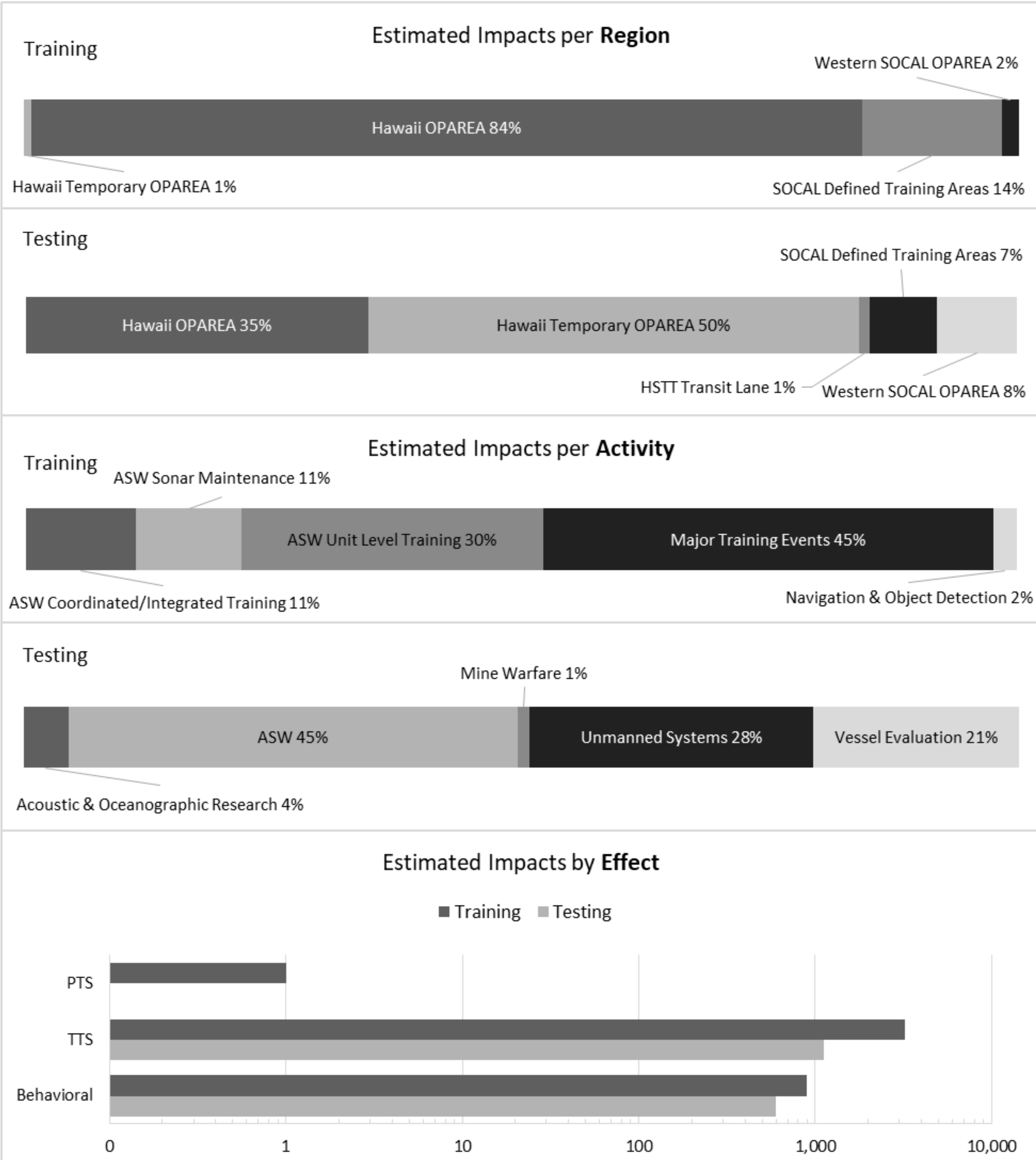


Figure 3.7-23: Minke Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts.
ASW = Anti-Submarine Warfare

Table 3.7-23: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	16%	16%
Hawaiian	84%	84%

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, TTS, and PTS under Alternative 2. See Figure 3.7-24 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-24).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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. See Figure 3.7-24 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-24).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 minke whales incidental to those activities.

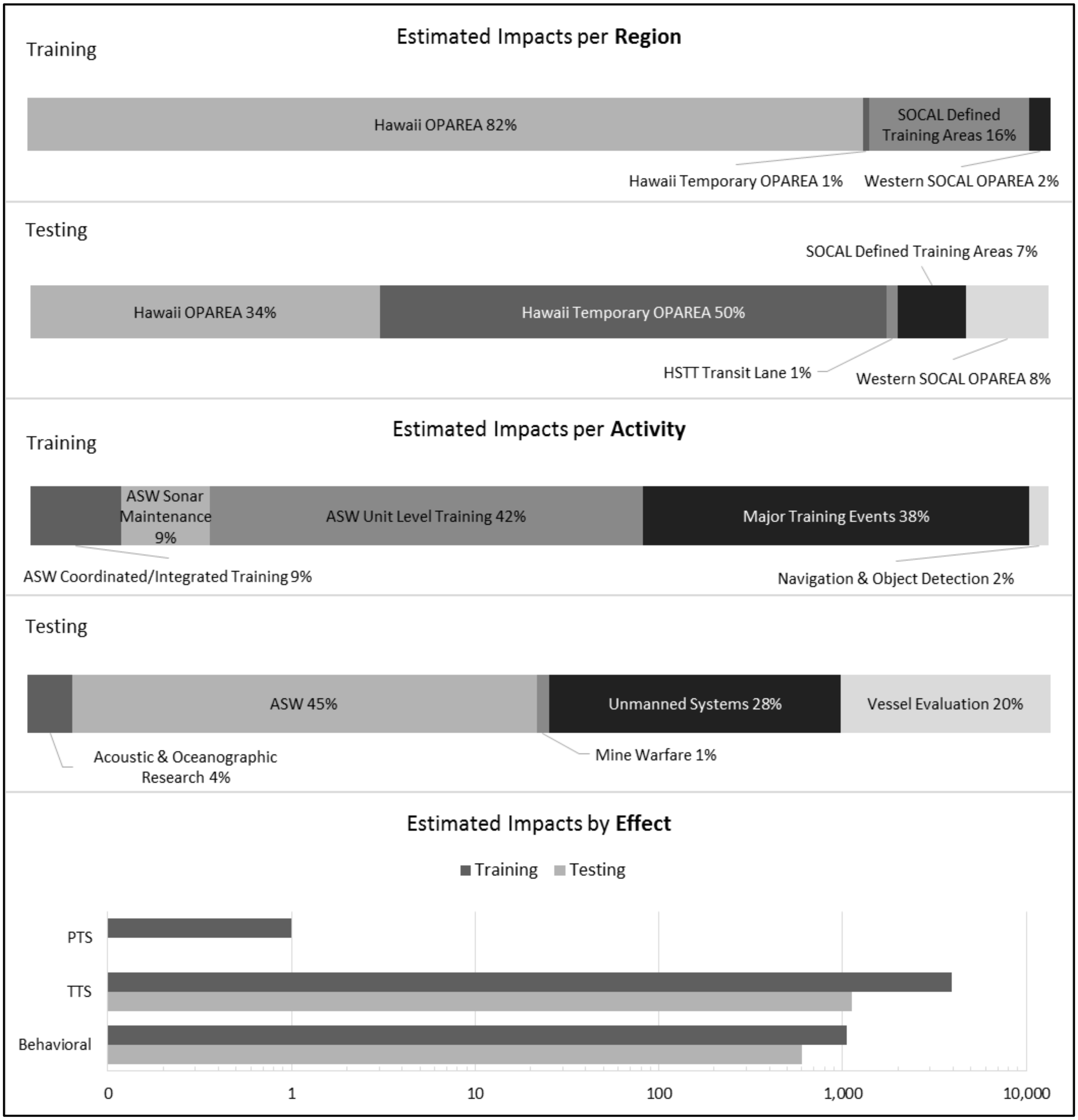


Figure 3.7-24: Minke Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts.
ASW = Anti-Submarine Warfare

Table 3.7-24: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	18%	16%
Hawaiian	82%	84%

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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1. See Figure 3.7-25 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-25).

As described for other 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 will be conducted 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 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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 1. See Figure 3.7-25 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-25).

As described for other 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 will 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 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.

Figure 3.7-25: Sei Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-25: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	69%	65%
Eastern North Pacific	31%	35%

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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2. See Figure 3.7-26 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-26).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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. The quantitative analysis estimates behavioral reactions and TTS under Alternative 2. See Figure 3.7-26 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-26).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 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.

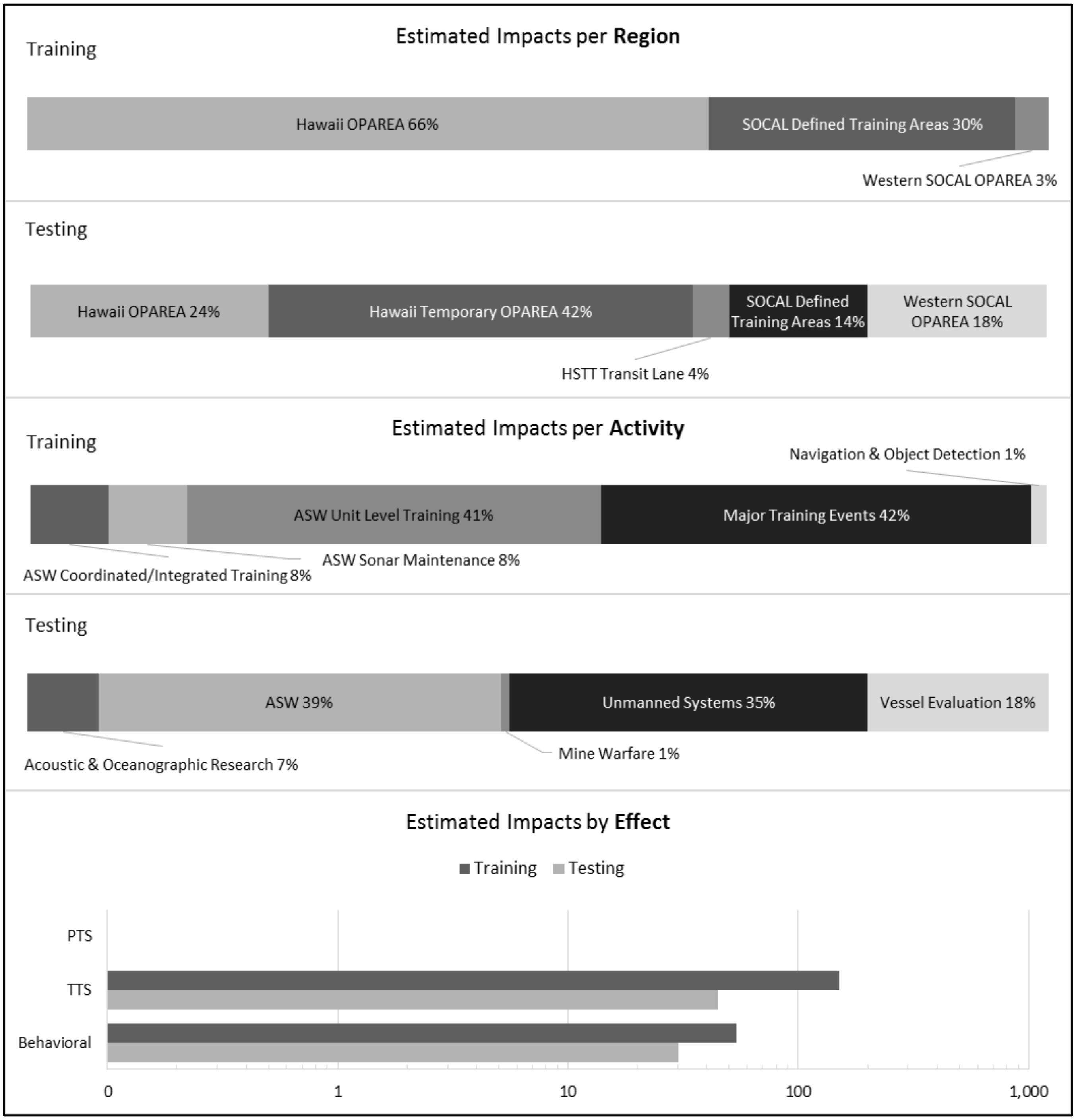


Figure 3.7-26: Sei Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-26: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	67%	65%
Eastern North Pacific	33%	35%

Odontocetes

Odontocetes may be exposed to sound from sonar and other transducers associated with training 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 3.7.2.1.4, 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 3.7.3.1.2 (Impacts from Sonar and Other Transducers).

A few 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 distance of up to 40 km and 50 km from the sound source, respectively. 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 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 3.7.3.1.1.5, 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 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 vessel). 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 3.7.3.1.1.5, 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 km. 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, although these activities typically do not use the same training locations day-after-day during multi-day activities. Sensitive species of odontocetes, such as beaked whales, may avoid the area for the duration of the event. Section 3.7.3.1.1.5 (Behavioral Reactions) discusses these species' observed reactions to sonar and other transducers. Displaced animals 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., 2015b; 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 animals would encounter a major training exercise more than once per year. 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 3.7.3.1.1.5, 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 threshold shift. 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 harbor porpoise and Kogia whales. Therefore, echolocation associated with feeding and navigation in odontocetes is unlikely to be affected by threshold shift 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 3.7.3.1.1.4 (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.

Sperm Whales (Endangered Species Act-Listed)

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

Sperm 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. See Figure 3.7-27 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-27).

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 will 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 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 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. See Figure 3.7-27 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-27).

As described for other 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 will 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 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.

Figure 3.7-27: Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-27: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	45%	58%
Hawaiian	55%	42%

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

Sperm 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. See Figure 3.7-28 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-28).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 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. See Figure 3.7-28 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-28).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 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.

Figure 3.7-28: Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-28: 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

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	45%	59%
Hawaiian	55%	41%

Kogia Whales

Kogia whales include two species that are often difficult to distinguish from one another: dwarf sperm whales and pygmy sperm whales. While impacts on the Hawaii populations of dwarf and pygmy sperm whales are modeled separately, impacts on the California, Oregon, and Washington stock of Kogia whales are not broken out by species.

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, TTS, and PTS under Alternative 1. See Figure 3.7-29 through Figure 3.7-31 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts on pygmy and dwarf sperm whales apply only to the Hawaiian stock. Estimated impacts on Kogia whales apply only to the California, Oregon, and Washington stock.

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 threshold shift 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A small and resident population area for the dwarf sperm whale identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population area only takes up a very small portion of the Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration. The sound from sonar or other transducers could expose animals within the dwarf sperm whale small and resident population area identified by Baird et al. (2015a) and impacts on behavior could occur. As discussed above, dwarf sperm whales may be more sensitive human sounds and activity. Some significant behavioral reactions to sonar within the identified area could occur; however, sound sources at ranges greater than a few kilometers are less likely to lead to significant reactions. A small number of significant behavioral responses from dwarf sperm whales could occur within the small and resident population area identified by Baird et al. (2015a) due to training with sonar and other transducers. However, abandonment of the identified areas by dwarf sperm whales is unlikely to occur because the Navy has been training in these areas with sonar and other transducers for decades.

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, TTS, and PTS under Alternative 1. See Figure 3.7-29 through Figure 3.7-31 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts on pygmy and dwarf sperm whales apply only to the Hawaiian stock. Estimated impacts on Kogia whales apply only to the California, Oregon, and Washington stock.

As described for other 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 threshold shift. 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A small and resident population area for the dwarf sperm whale identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population area only takes up a very small portion of the Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration. The sound from sonar or other transducers could expose animals within the dwarf sperm whale small and resident population area identified by Baird et al. (2015a) and impacts on behavior could occur. As discussed above, dwarf sperm whales may be more sensitive human sounds and activity. Some significant behavioral reactions to sonar within the identified area could occur; however, sound sources at ranges greater than a few kilometers are less likely to lead to significant reactions. A small number of significant behavioral responses from dwarf sperm whales could occur within the small and resident population area identified by Baird et al. (2015a) due to testing with sonar and other transducers. However, abandonment of the identified areas by dwarf sperm whales is unlikely to occur because the Navy has been testing in these areas with sonar and other transducers for decades.

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.

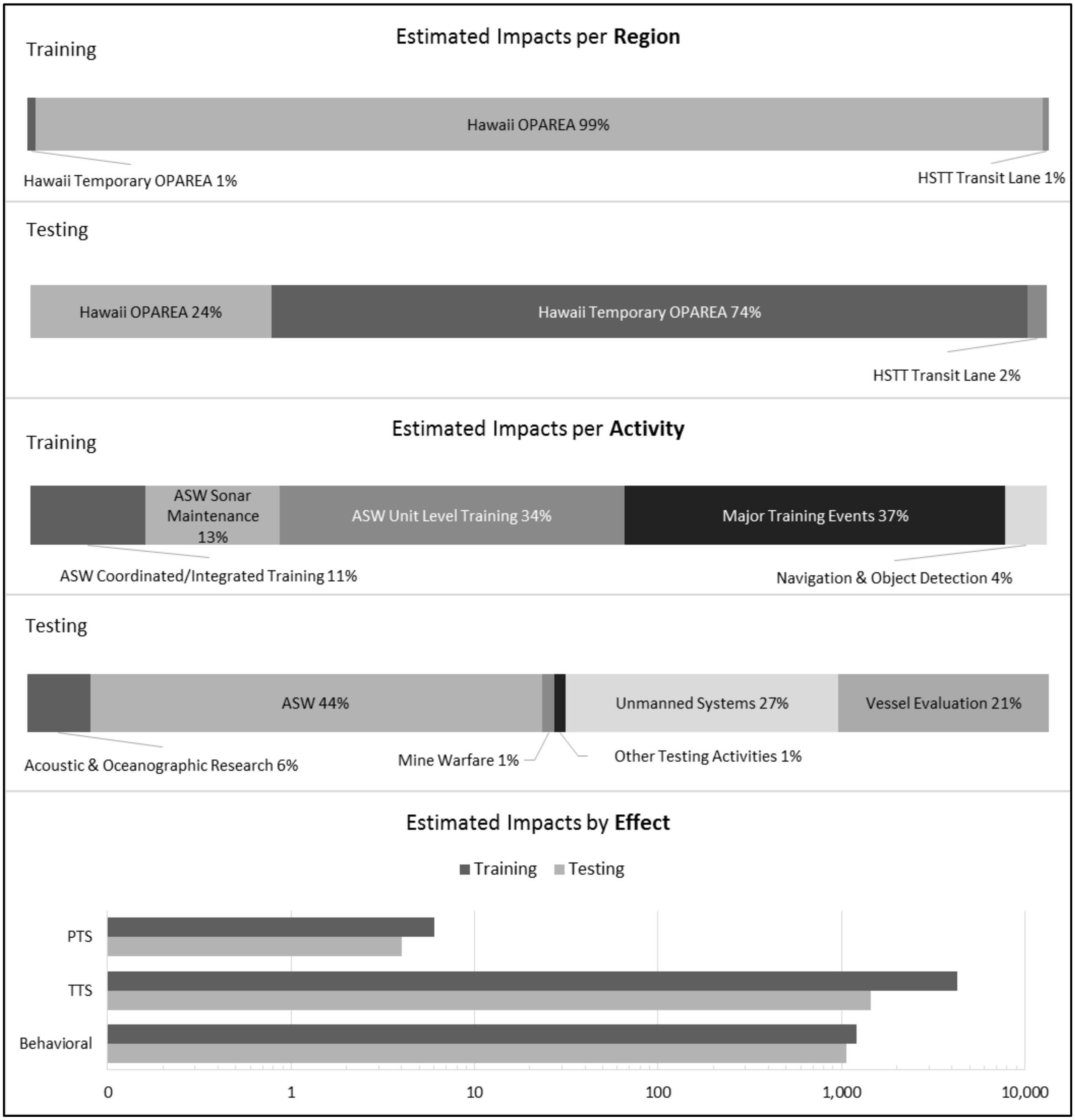


Figure 3.7-29: Pygmy Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

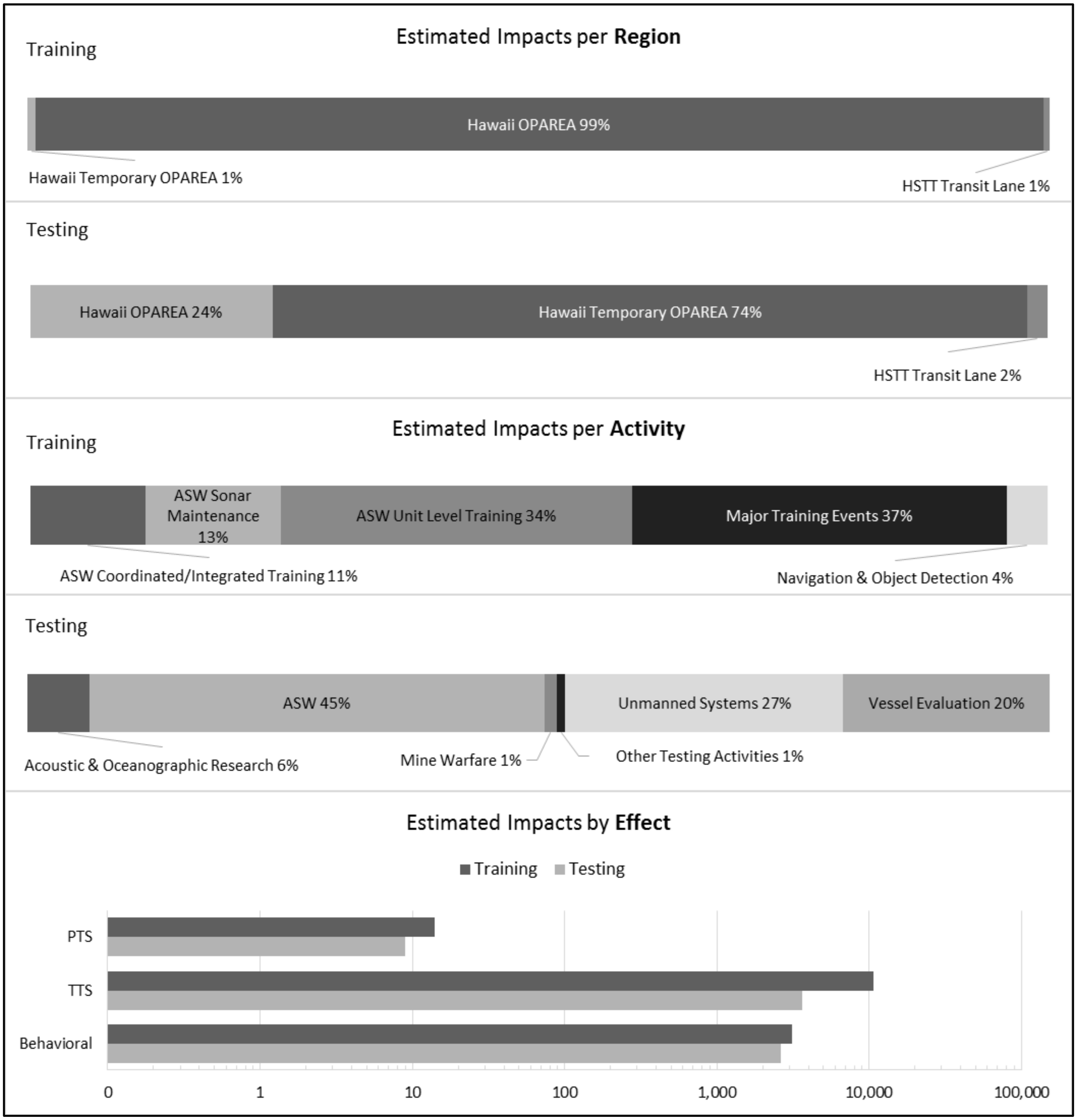


Figure 3.7-30: Dwarf Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

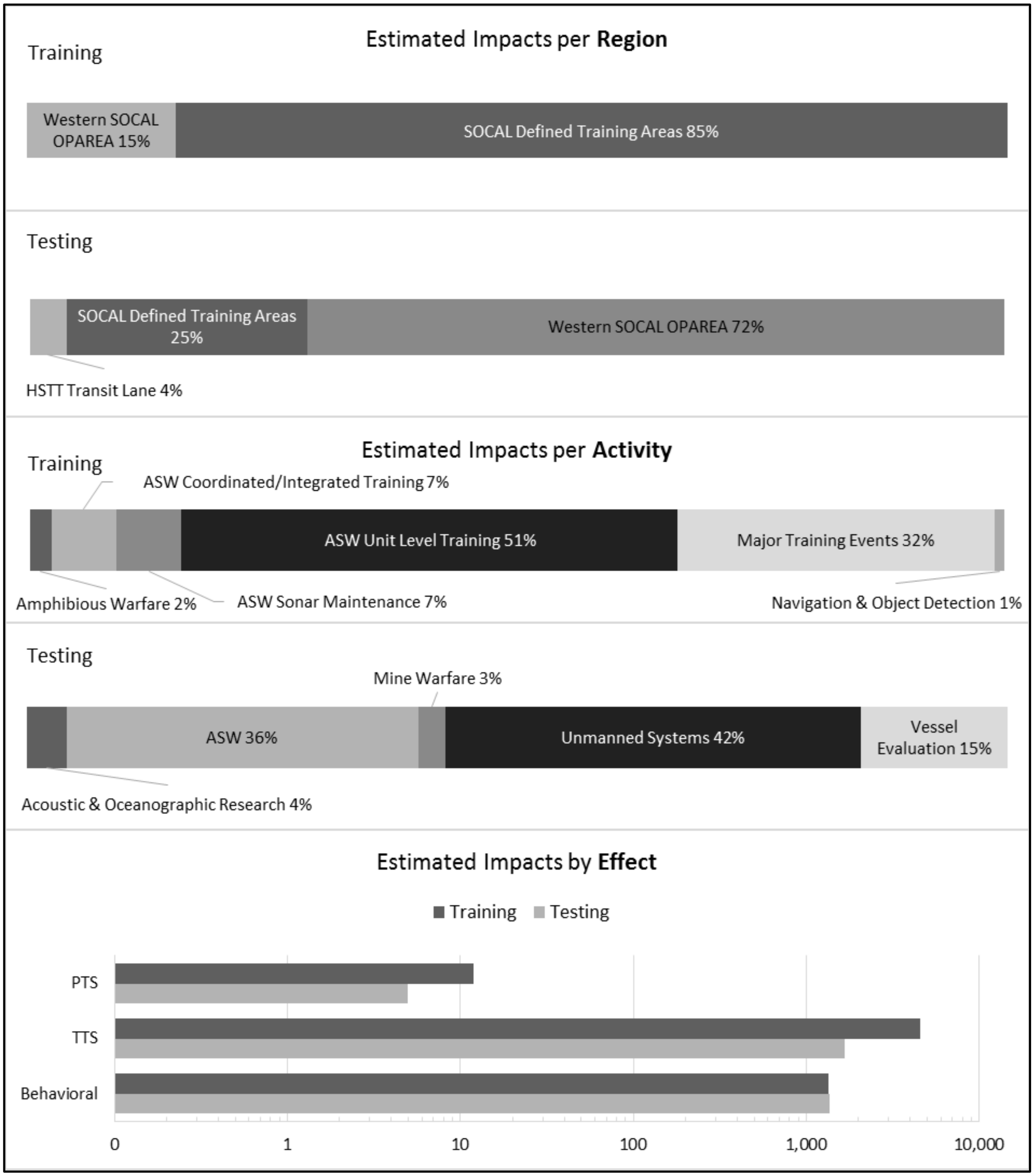


Figure 3.7-31: Kogia Whales Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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, TTS, and PTS under Alternative 2. See Figure 3.7-32 through Figure 3.7-34 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts on pygmy and dwarf sperm whales apply only to the Hawaiian stock. Estimated impacts on Kogia whales apply only to the California, Oregon, and Washington stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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. See Figure 3.7-32 through Figure 3.7-34 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts on pygmy and dwarf sperm whales apply only to the Hawaiian stock. Estimated impacts on Kogia whales apply only to the California, Oregon, and Washington stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 Kogia whales (i.e., dwarf and pygmy sperm whales) incidental to those activities.

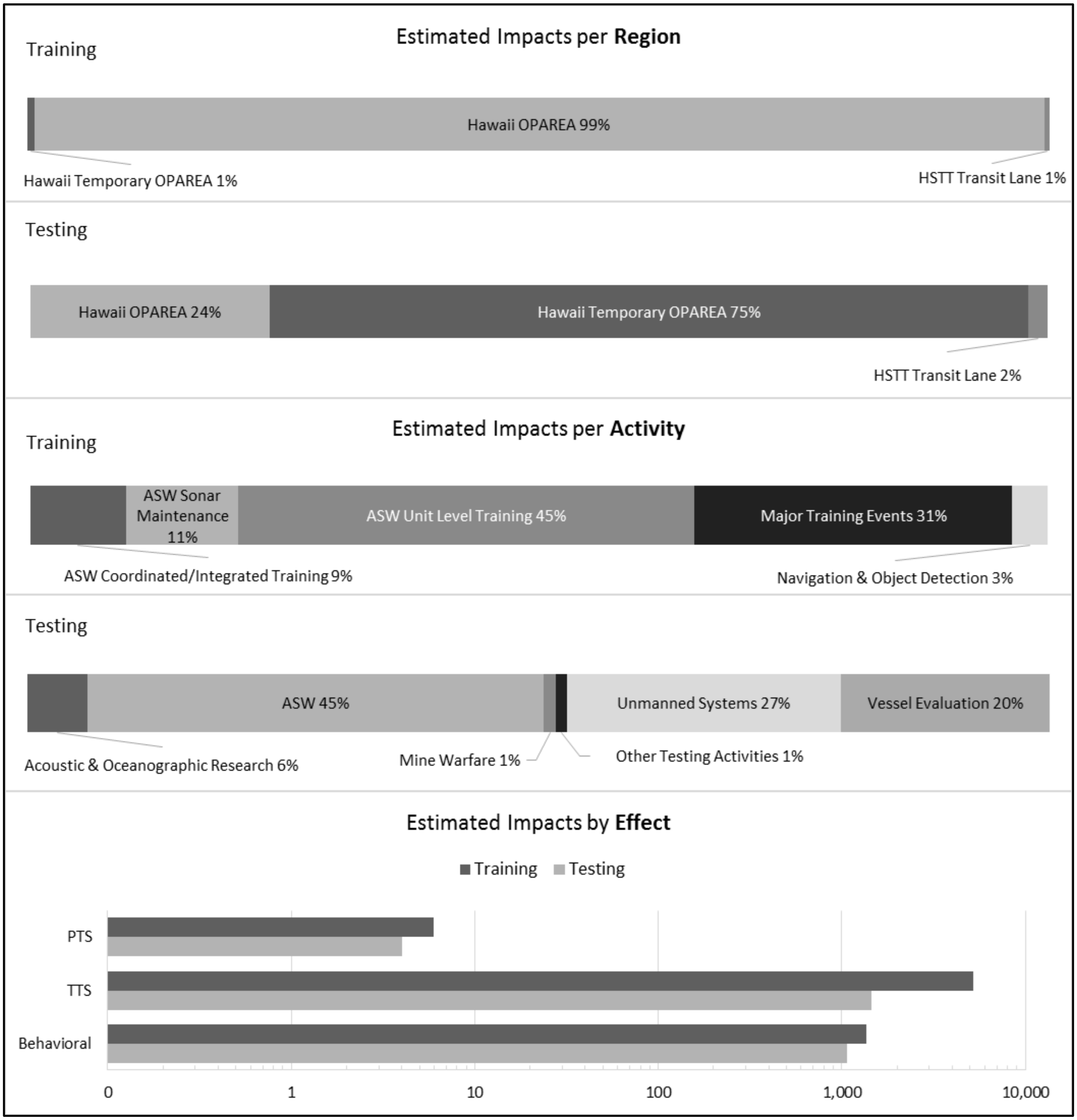


Figure 3.7-32: Pygmy Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

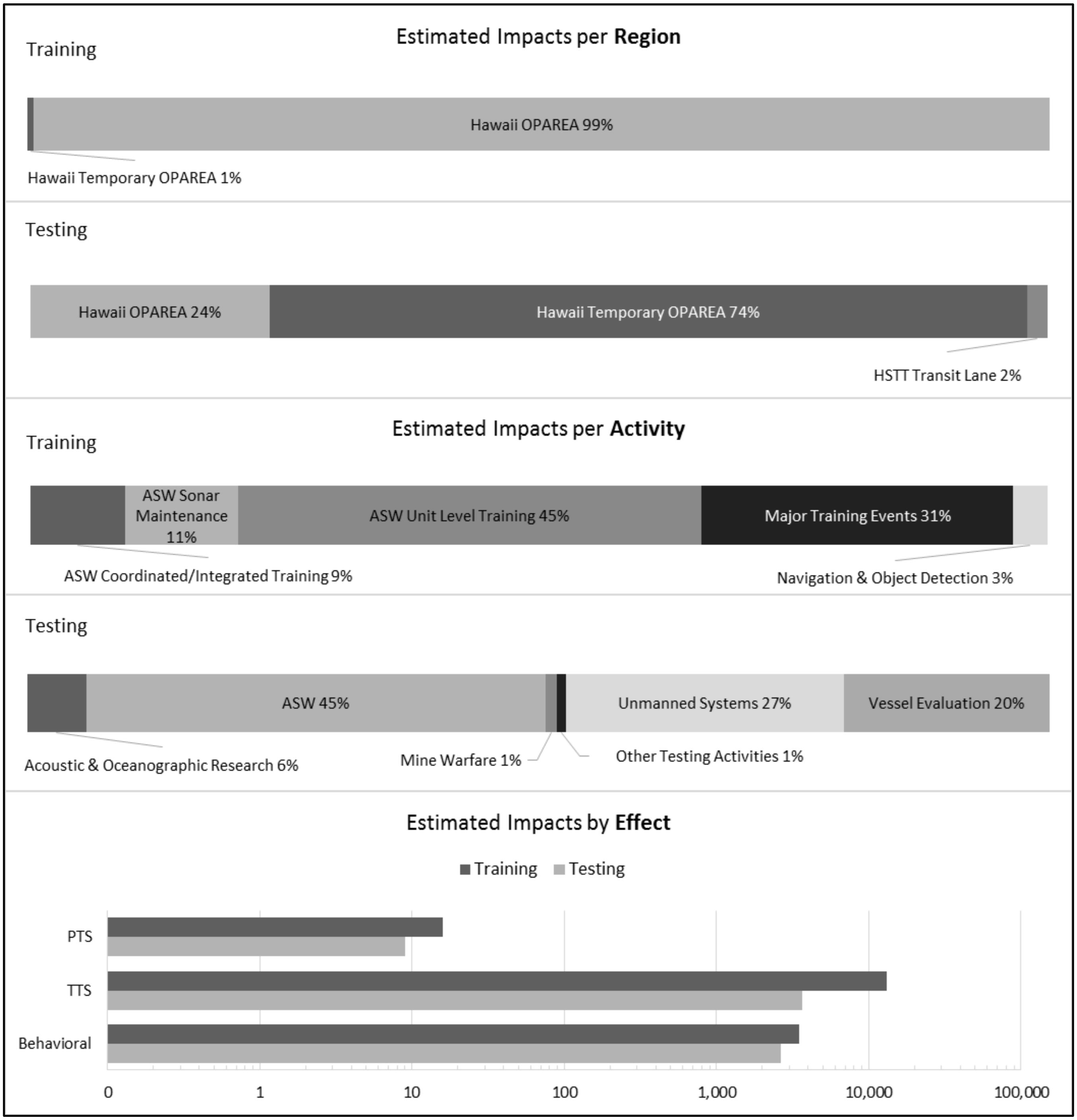


Figure 3.7-33: Dwarf Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

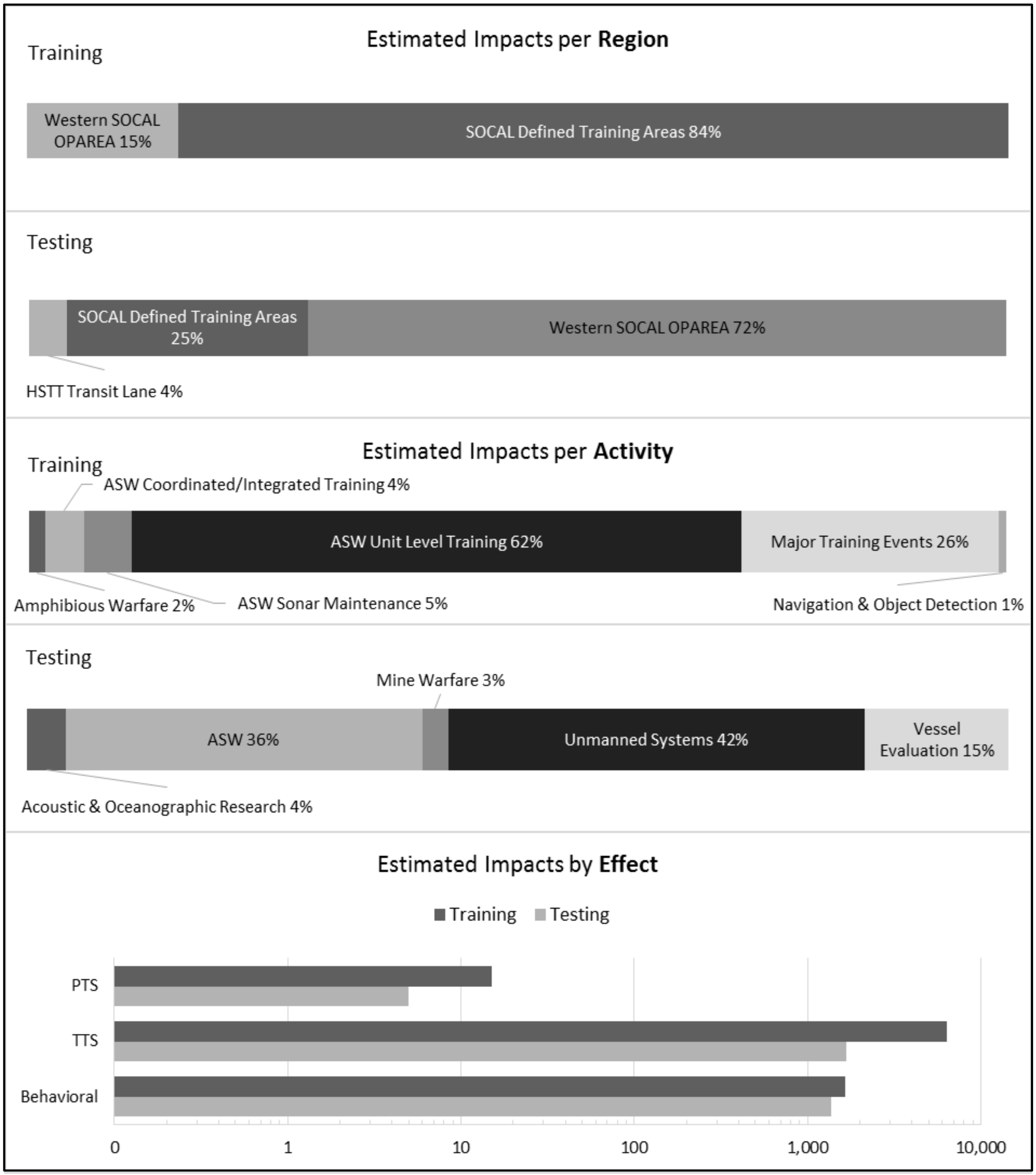


Figure 3.7-34: Kogia Whales Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

Beaked Whales

Beaked whales within the HSTT study area include: Baird's beaked whale, Blainville's beaked whale, Cuvier's beaked whale, Hubb's beaked whale, Ginkgo-toothed beaked whale, Longman's beaked whale, Perrin's beaked whale, Stejneger's beaked whale, and the Pygmy beaked whale. Impacts on 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 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 3.7.3.1.1.5, 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 (3.7.3.1.1.5, 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., 2015b; 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. 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 active acoustic 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. See Figure 3.7-35 through Figure 3.7-39 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts on Baird's beaked whales and the small beaked whale guild (Mesoplodon spp.) apply only to the California, Oregon, and Washington stock. Estimated impacts on

Blainville's beaked whales, and Longman's beaked whales apply only to the Hawaiian stock. Estimated impacts on Cuvier's beaked whales apply multiple stocks (see Table 3.7-xx).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for Cuvier's beaked whales and small and resident population area for Blainville's beaked whales identified by Baird et al. (2015a) are within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. The identified small and resident population areas only take up a very small portion of the Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration. The sound from sonar or other transducers could expose animals within the beaked whale small and resident population areas identified by Baird et al. (2015a) and impacts on behavior could occur. As discussed above, beaked whales are one of the most sensitive species groups to sounds from sonars that have been studied, especially those used during anti-submarine warfare training. Some significant behavioral reactions to sonar are likely within the identified areas; however, sound sources at ranges greater than a few tens of kilometers are less likely to lead to significant reactions. Therefore, some impacts on beaked whale natural behaviors could occur within the small and resident population areas identified by Baird et al. (2015a) due to training with sonar and other transducers. However, abandonment of the identified areas by Cuvier's or Blainville's beaked whales is unlikely to occur because the Navy has been training in these areas with sonar and other transducers for decades.

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, Blainville's, Cuvier's, Longman'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. See Figure 3.7-35 through Figure 3.7-39 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts on Baird's beaked whales and the small beaked whale guild (Mesoplodon spp.) apply only to the California, Oregon, and Washington stock. Estimated impacts on Blainville's beaked whales and Longman's beaked whales apply only to the Hawaiian stock.

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for Cuvier's beaked whales and small and resident population area for Blainville's beaked whales identified by Baird et al. (2015a) are within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. The identified small and resident population areas only take up a very small portion of the Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration. The sound from sonar or other transducers could expose animals within the beaked whale small and resident population areas identified by Baird et al. (2015a) and impacts on behavior could occur. As discussed above, beaked whales are one of the most sensitive species studied to sounds from sonars, especially those used during anti-submarine warfare testing. Some significant behavioral reactions to sonar are likely within the identified areas; however, sound sources at ranges greater than a few tens of kilometers are less likely to lead to significant reactions. Therefore, some impacts on beaked whale natural behaviors could occur within the small and resident population areas identified by Baird et al. (2015a) due to testing with sonar and other transducers. However, abandonment of the identified areas by Cuvier's or Blainville's beaked whales is unlikely to occur because the Navy has been testing in these areas with sonar and other transducers for decades.

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, Blainville's, Cuvier's, Longman'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.

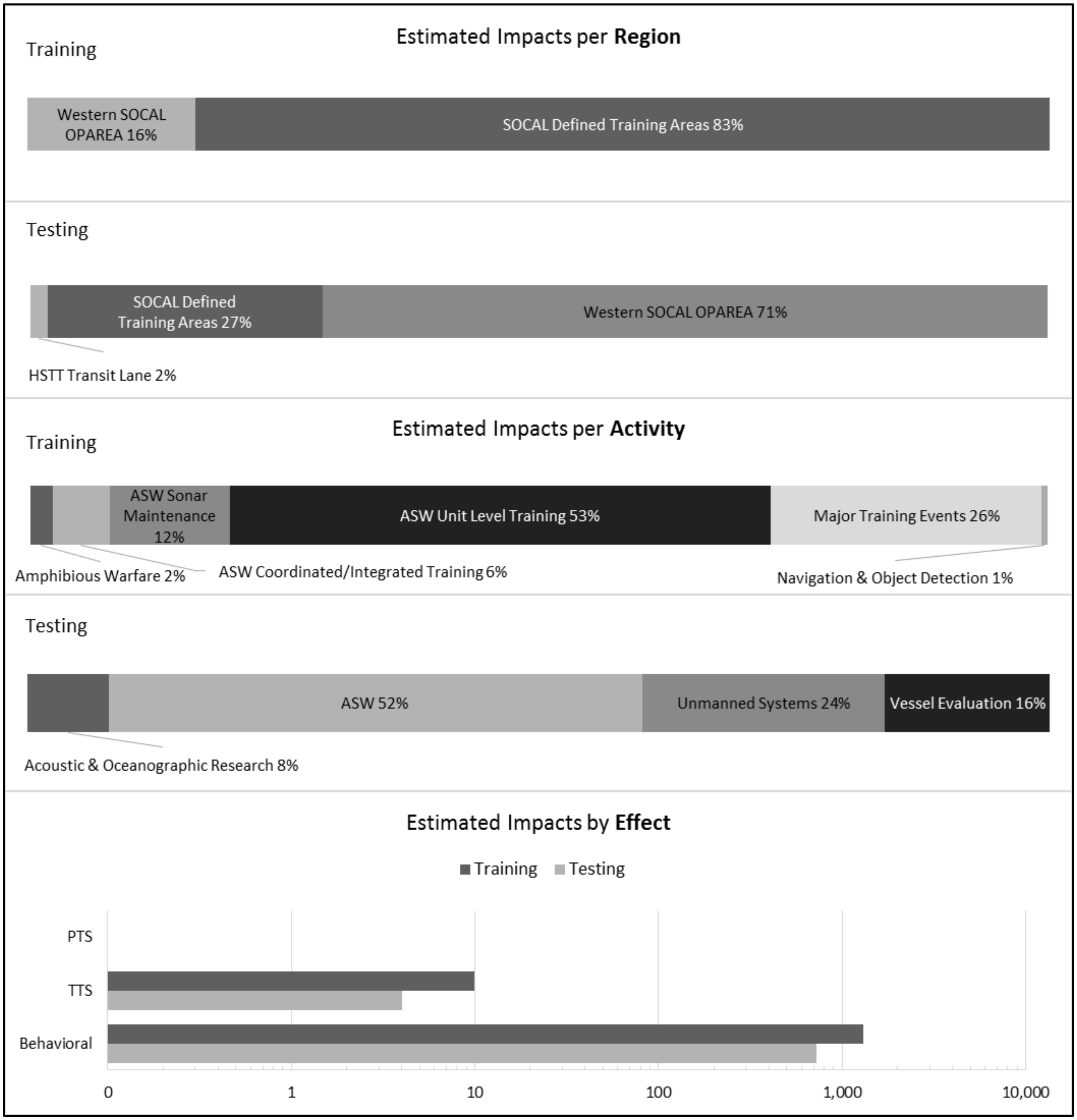


Figure 3.7-35: Baird's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

Figure 3.7-36: Blainville's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

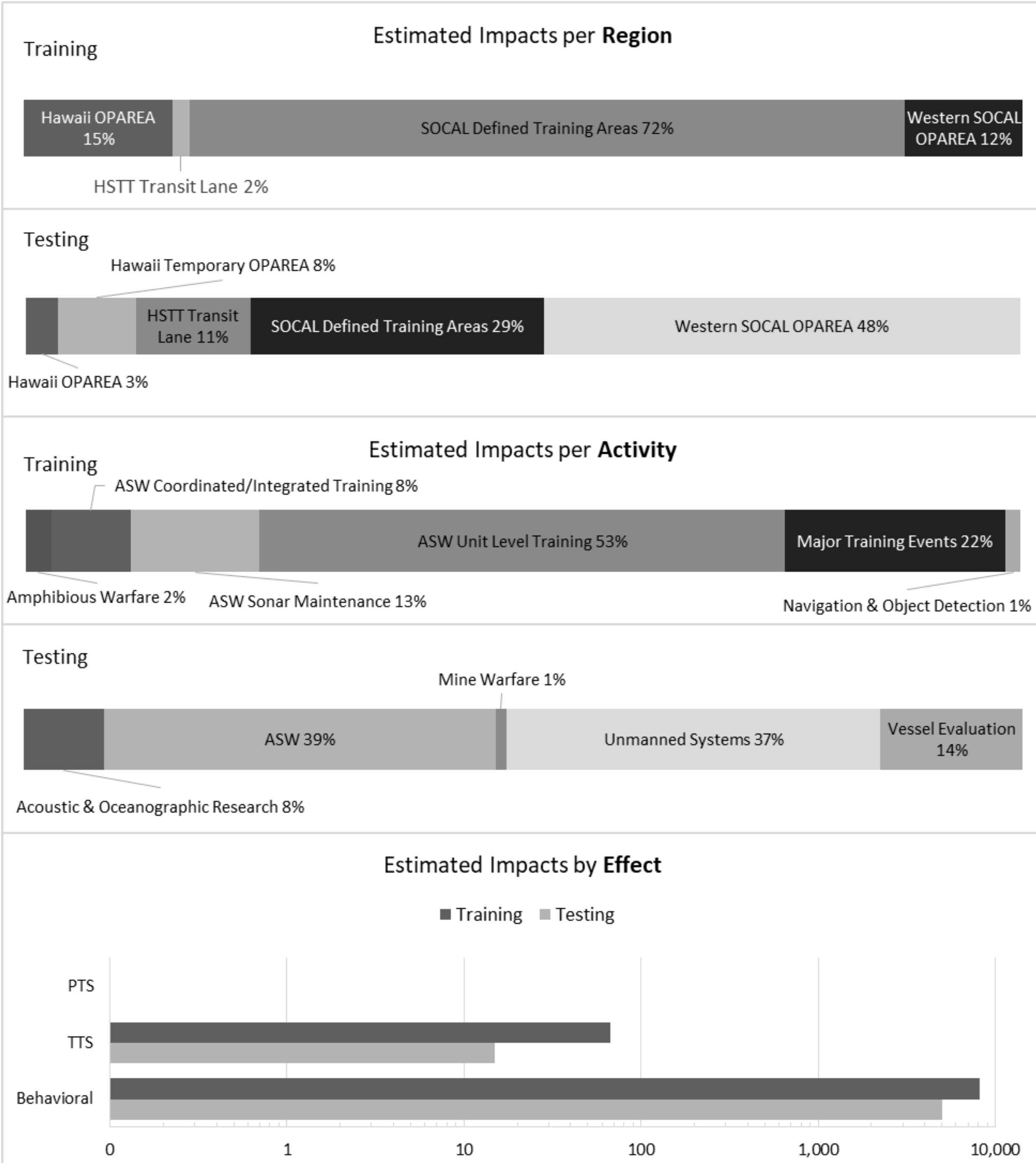


Figure 3.7-37: Cuvier's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

Table 3.7-29: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	85%	89%
Hawaiian	15%	11%

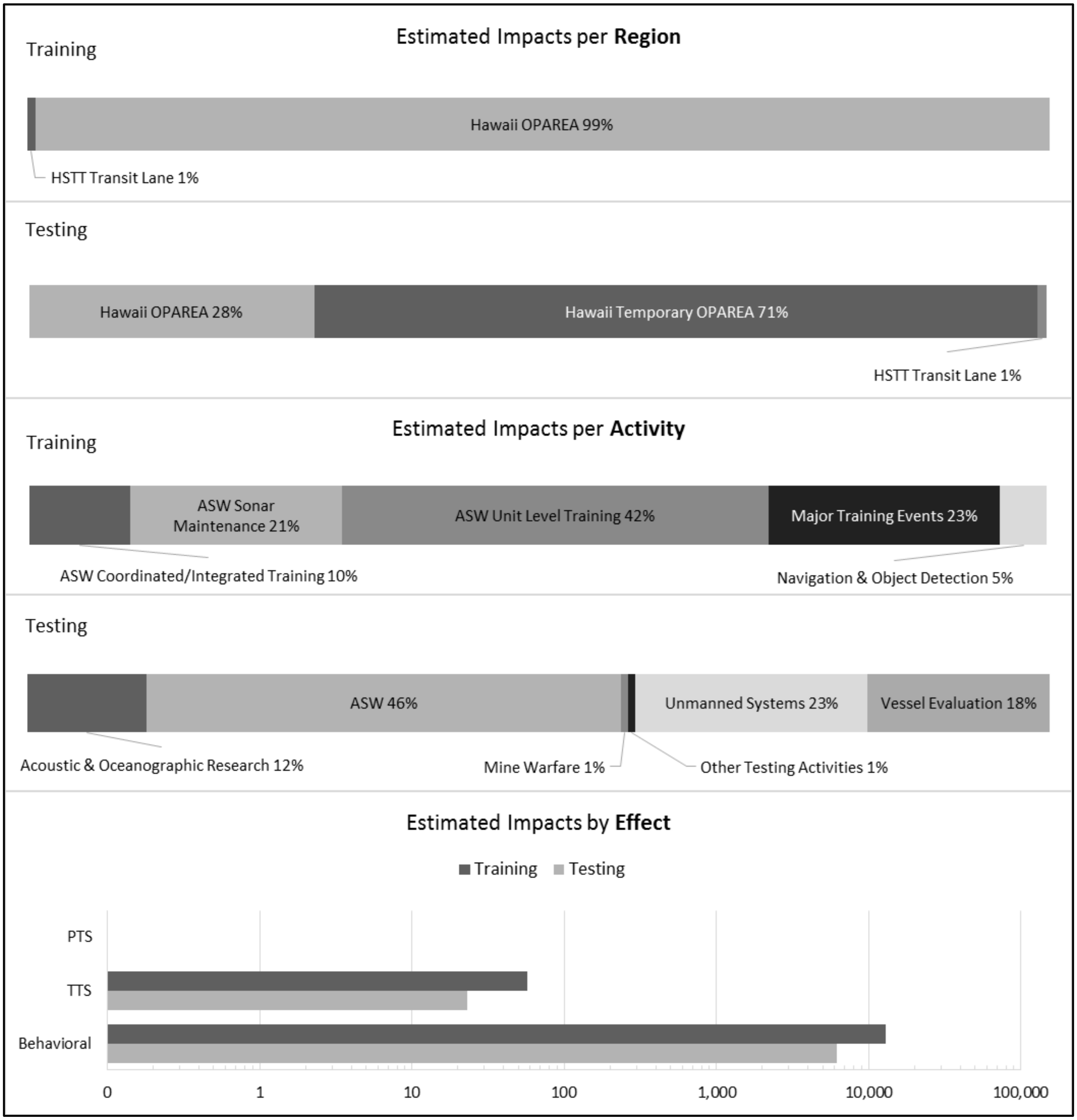


Figure 3.7-38: Longman's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

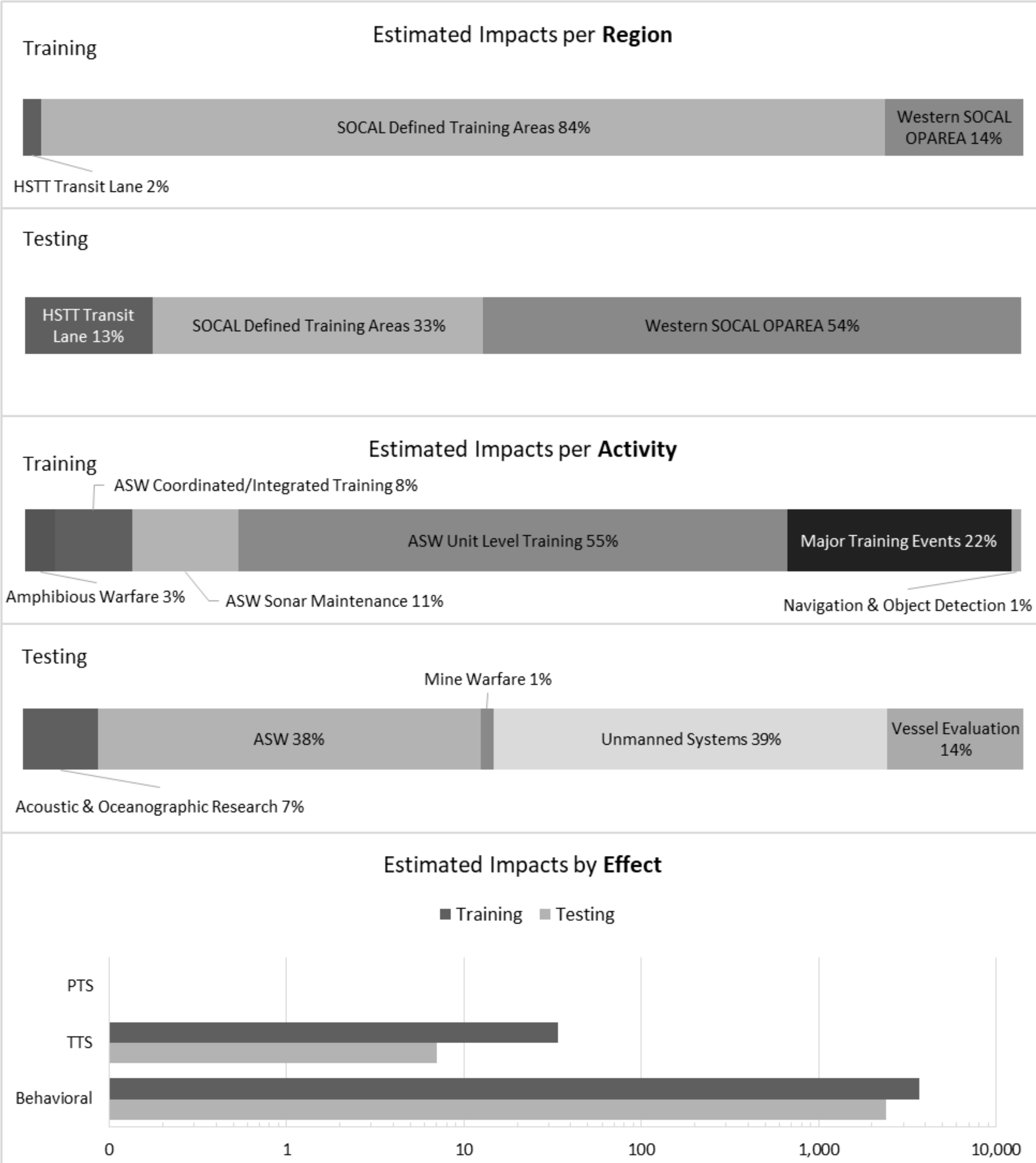


Figure 3.7-39: Mesoplodon Spp. (Small Beaked Whale Guild) Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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. See Figure 3.7-40 through Figure 3.7-44 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts on Baird's beaked whales and the small beaked whale guild (Mesoplodon spp.) apply only to the California, Oregon, and Washington stock. Estimated impacts on Blainville's beaked whales and Longman's beaked whales apply only to the Hawaiian stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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, Blainville's, Cuvier's, Longman'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. See Figure 3.7-40 through Figure 3.7-44 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts on Baird's beaked whales and the small beaked whale guild (Mesoplodon spp.) apply only to the California, Oregon, and Washington stock. Estimated impacts on Blainville's beaked whales and Longman's beaked whales apply only to the Hawaiian stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 Baird's, Blainville's, Cuvier's, Longman's, and Mesoplodon spp. beaked whales (species within the beaked whale guild) incidental to those activities.

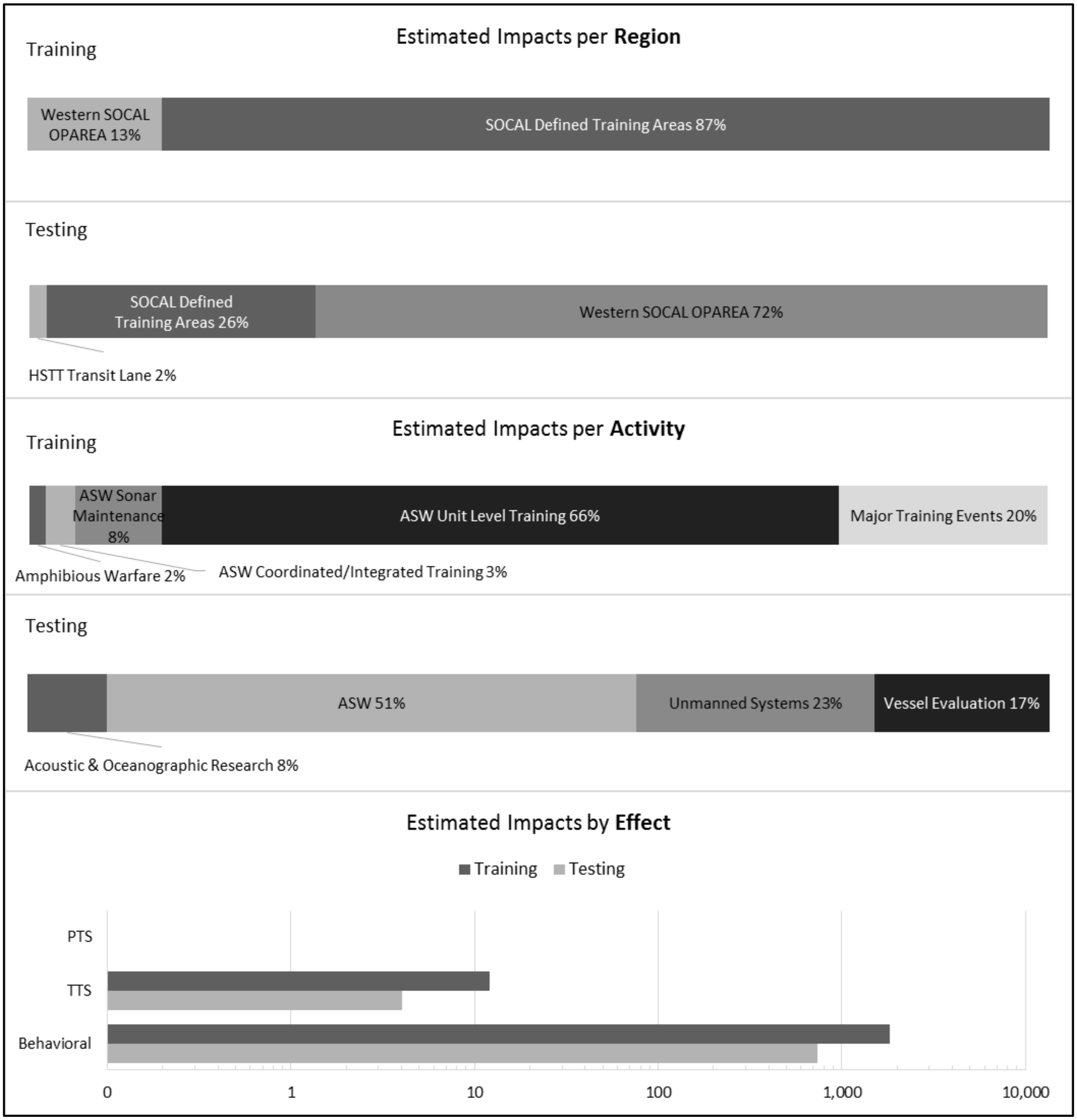


Figure 3.7-40: Baird's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

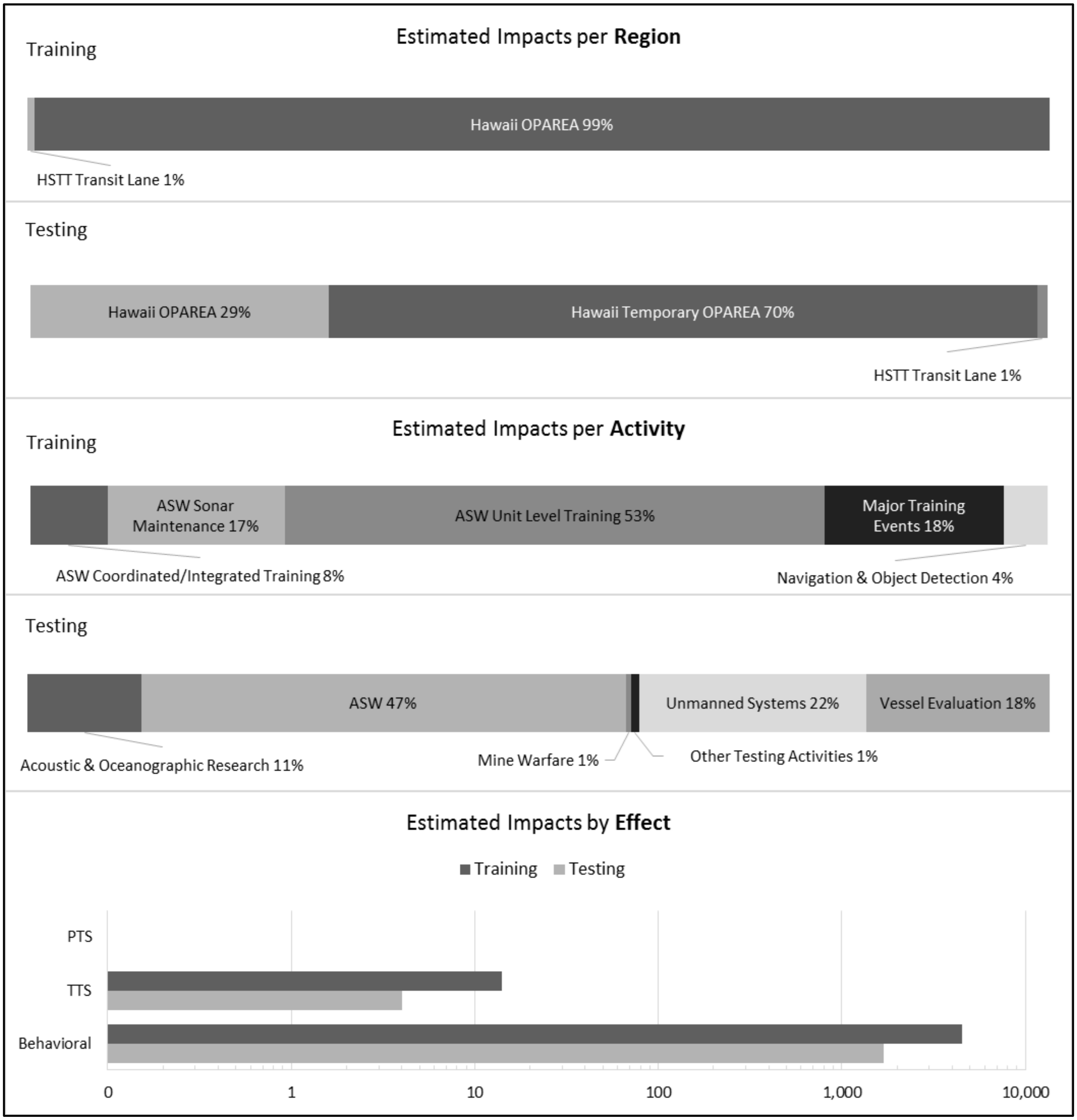


Figure 3.7-41: Blainville's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

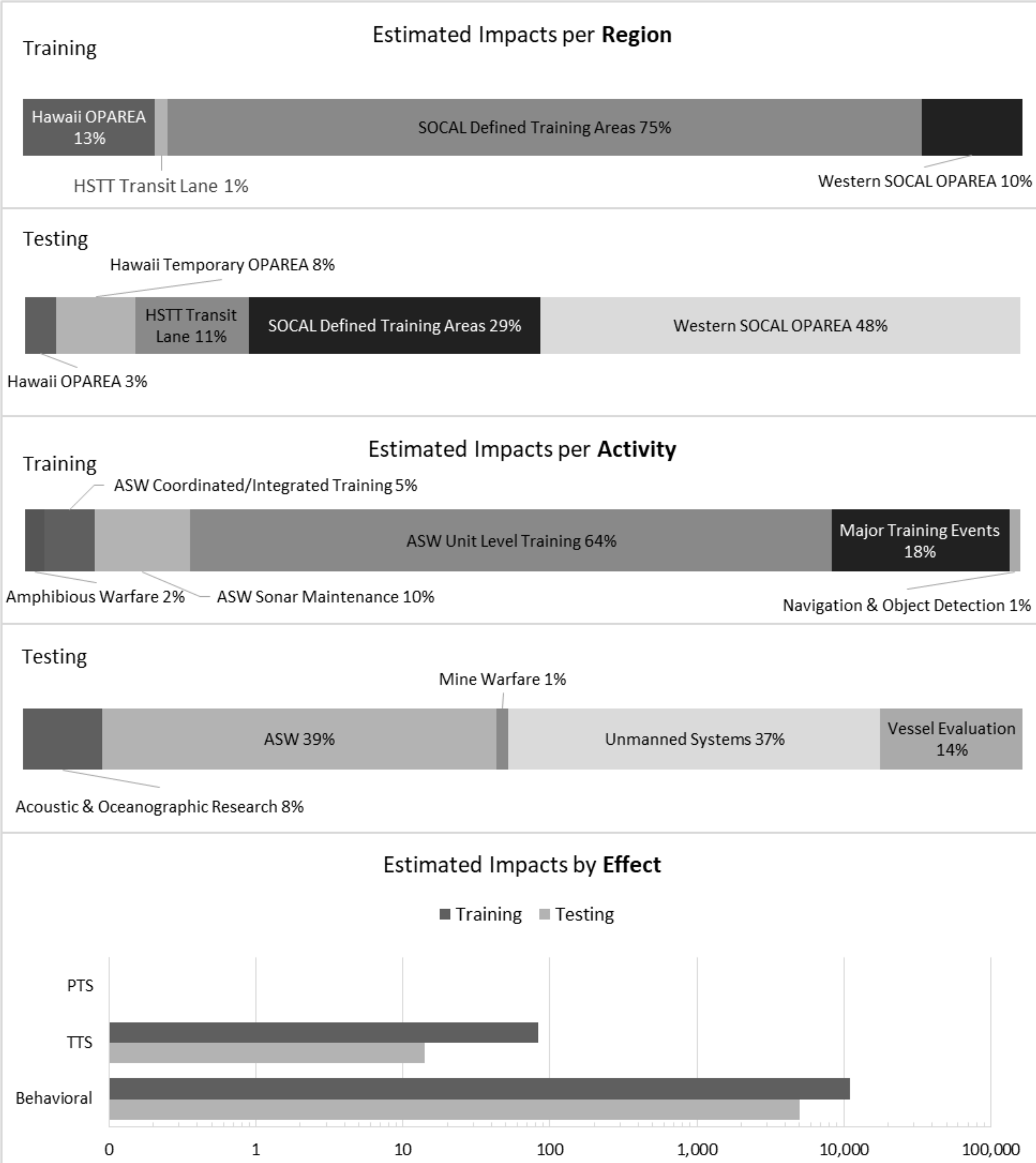


Figure 3.7-42: Cuvier's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

Table 3.7-30: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	87%	89%
Hawaiian	13%	11%

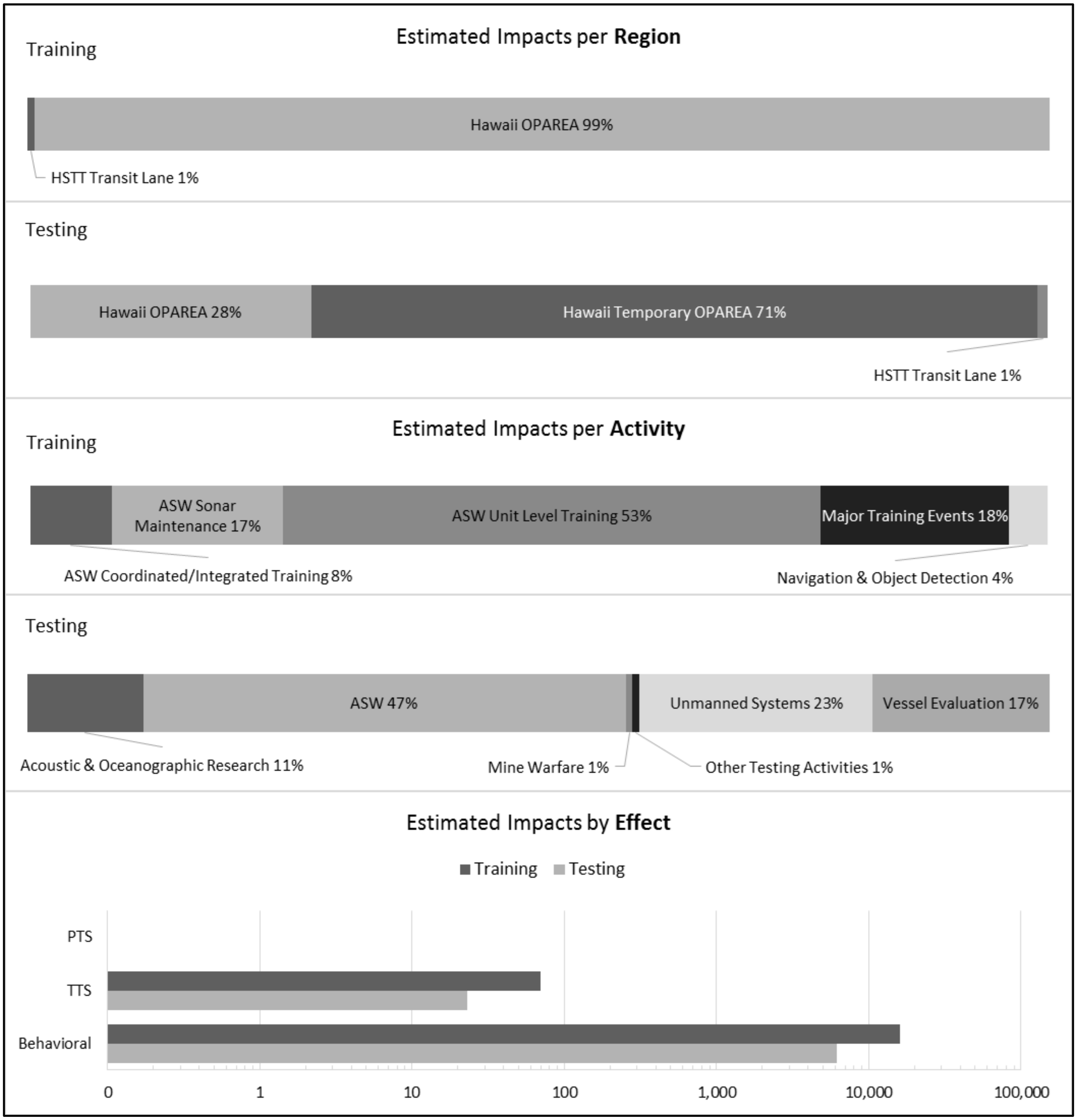


Figure 3.7-43: Longman's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

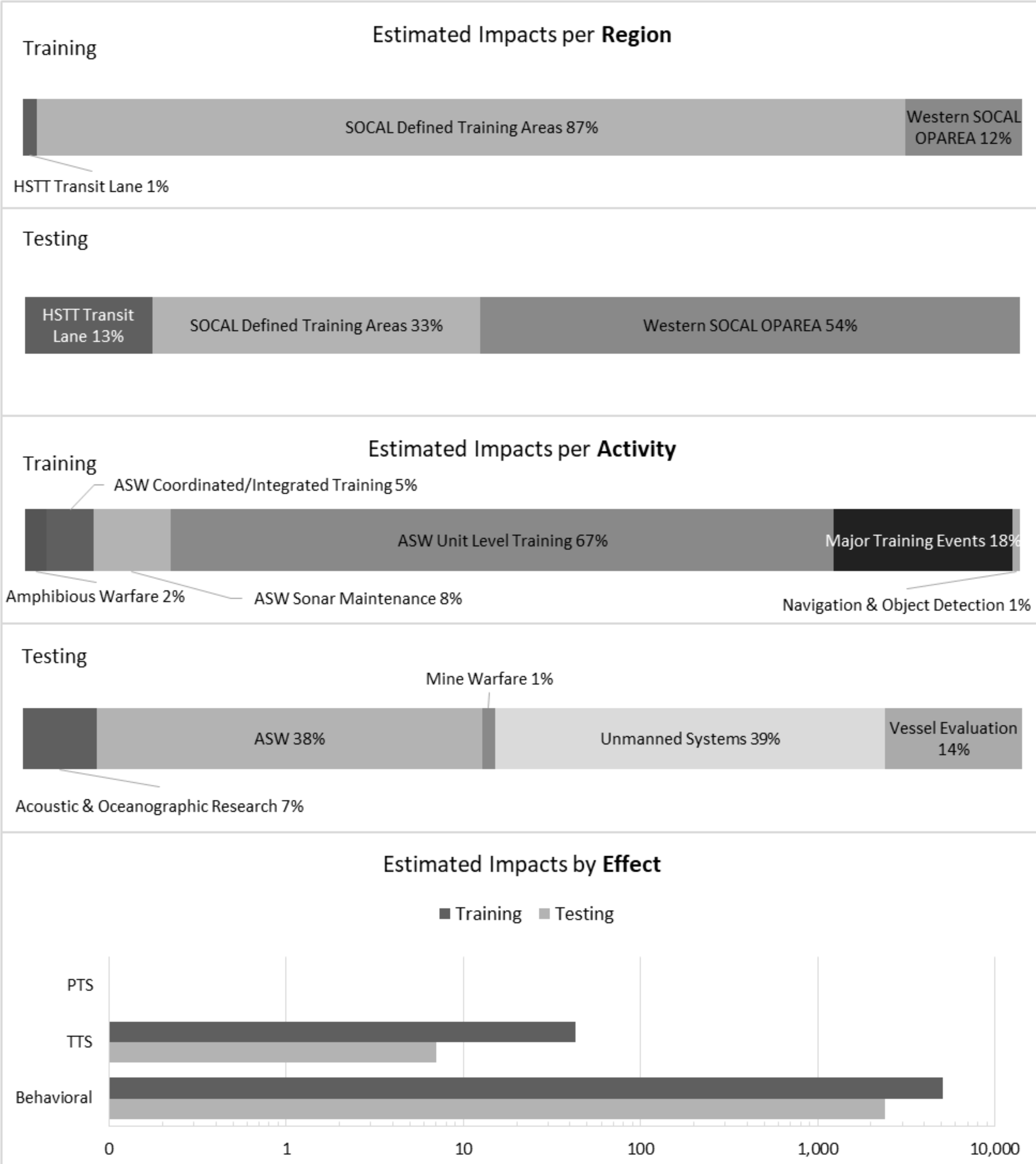


Figure 3.7-44: Mesoplodon Spp. (Small Beaked Whale Guild) Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for these species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

Bottlenose Dolphins

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

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 and TTS under Alternative 1. See Figure 3.7-45 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-31).

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Four small and resident population areas for bottlenose dolphins identified by Baird et al. (2015a) are within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within shallow, near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, although anti-submarine warfare activities could occur in waters deeper than 200 m around the main Hawaiian Islands, and sonar may be used as ships enter and exit Pearl Harbor. However, sound from sonar or other transducers could still expose animals within the identified bottlenose dolphin small and resident population areas identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, bottlenose dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on bottlenose dolphin natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015a).

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 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

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 and TTS under Alternative 1. See Figure 3.7-45 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-31).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Four small and resident population areas for bottlenose dolphins identified by Baird et al. (2015a) are within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, although anti-submarine warfare activities could occur in waters deeper than 200 m around the main Hawaiian Islands, and sonar may be used as ships enter and exit Pearl Harbor. However, sound from sonar or other transducers could still expose animals within the identified bottlenose dolphin small and resident population areas identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, bottlenose dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on bottlenose dolphin natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015a).

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 bottlenose dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Figure 3.7-45: Bottlenose Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-31: Estimated Impacts on Individual Bottlenose Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
4-Island	0%	1%
California Coastal	0%	6%
California, Oregon, and Washington Offshore	75%	85%
Hawaiian Pelagic	5%	5%
Kauai and Niihau	0%	2%
Oahu	19%	2%

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

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 and TTS under Alternative 2. See Figure 3.7-46 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-32).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 bottlenose dolphins incidental to those activities.

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

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 and TTS under Alternative 2. See Figure 3.7-46 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-32).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 bottlenose dolphins incidental to those activities.

Figure 3.7-46: Bottlenose Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-32: Estimated Impacts on Individual Bottlenose Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
4-Island	0%	1%
California Coastal	0%	6%
California, Oregon, and Washington Offshore	78%	86%
Hawaiian Pelagic	5%	4%
Kauai and Niihau	0%	2%
Oahu	16%	2%

False Killer Whales

The Main Hawaiian Islands Insular stock of false killer whales is Endangered Species Act-listed.

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

False 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. See Figure 3.7-47 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-33).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected. Mitigation areas that overlap areas of high use by main Hawaiian Islands insular false killer whales include the Hawaii Island Mitigation Area and 4-Islands Region Mitigation Area. Although false killer whales have not been observed responding to mid-frequency active sonar, these mitigation areas were largely chosen to provide a reduction of exposure to mid-frequency active sonar on this rare stock.

A small and resident population area for the endangered insular population of false killer whales identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within shallow, near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training exercises. However, sound from sonar or other transducers could still expose animals within the false killer whale small and resident population area identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, false killer whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on false killer whale natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015a).

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 false 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 main Hawaiian Islands Insular stock of false killer whales and main Hawaiian Islands Insular false killer whale critical habitat. 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

False 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. See Figure 3.7-47 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-33).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for the endangered insular population of false killer whales identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the false killer whale small and resident population area identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, false killer whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on false killer whale natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015a).

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 false 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 main Hawaiian Islands Insular stock of false killer whales and main Hawaiian Islands Insular false killer whale critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

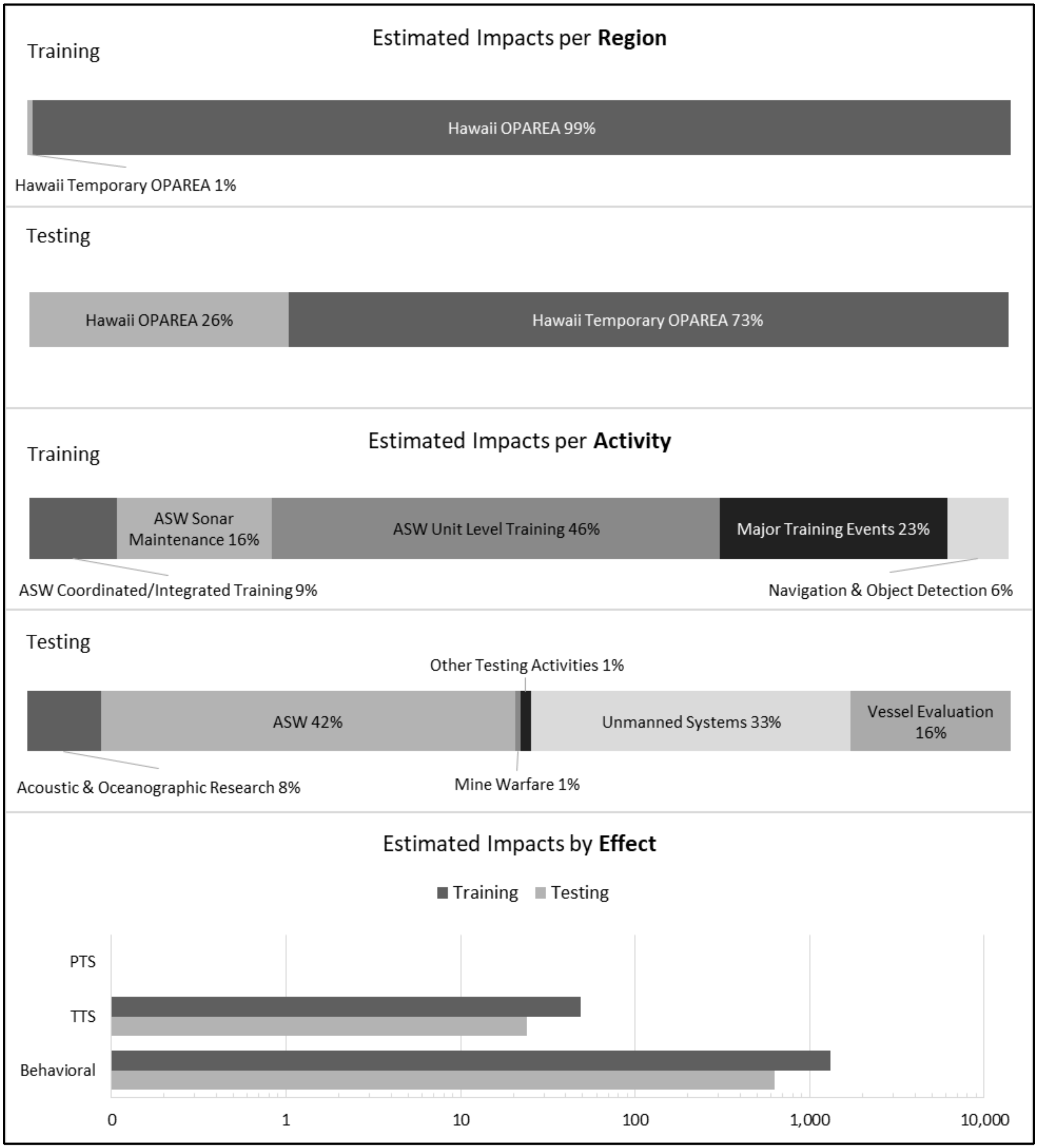


Figure 3.7-47: False Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-33: Estimated Impacts on Individual False Killer Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaii Pelagic	52%	52%
Northwestern Hawaiian Islands	19%	19%
Main Hawaiian Islands Insular	30%	28%

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

False 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. See Figure 3.7-48 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-34).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 training activities as described under Alternative 2 will result in the unintentional taking of false 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 main Hawaiian Islands Insular stock of false killer whales and main Hawaiian Islands Insular false killer whale critical habitat.

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

False 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. See Figure 3.7-48 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-34).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 false 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 main Hawaiian Islands Insular stock of false killer whales and main Hawaiian Islands Insular false killer whale critical habitat.

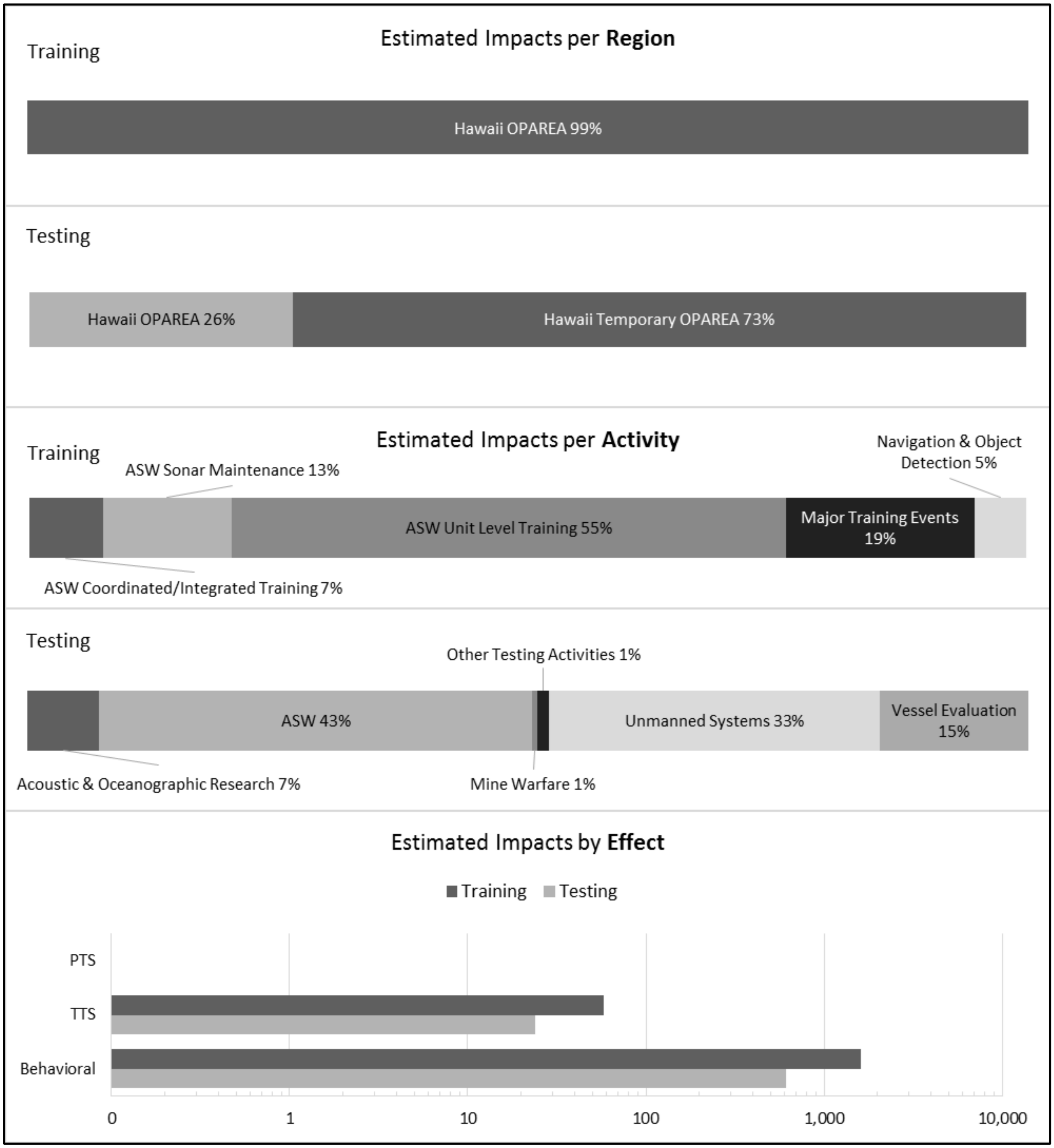


Figure 3.7-48: False Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-34: Estimated Impacts on Individual False Killer Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaii Pelagic	51%	52%
Northwestern Hawaiian Islands	19%	19%
Main Hawaiian Islands Insular	30%	29%

Fraser's Dolphins

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

Fraser's dolphin 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. See Figure 3.7-49 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

As described for other 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 will 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 Fraser's dolphin 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

Fraser'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. See Figure 3.7-49 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

As described for other 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 will 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 Fraser's dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Figure 3.7-49: Fraser's Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

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

Fraser'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. See Figure 3.7-50 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 Fraser's dolphins incidental to those activities.

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

Fraser's dolphin 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. See Figure 3.7-50 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 Fraser's dolphins incidental to those activities.

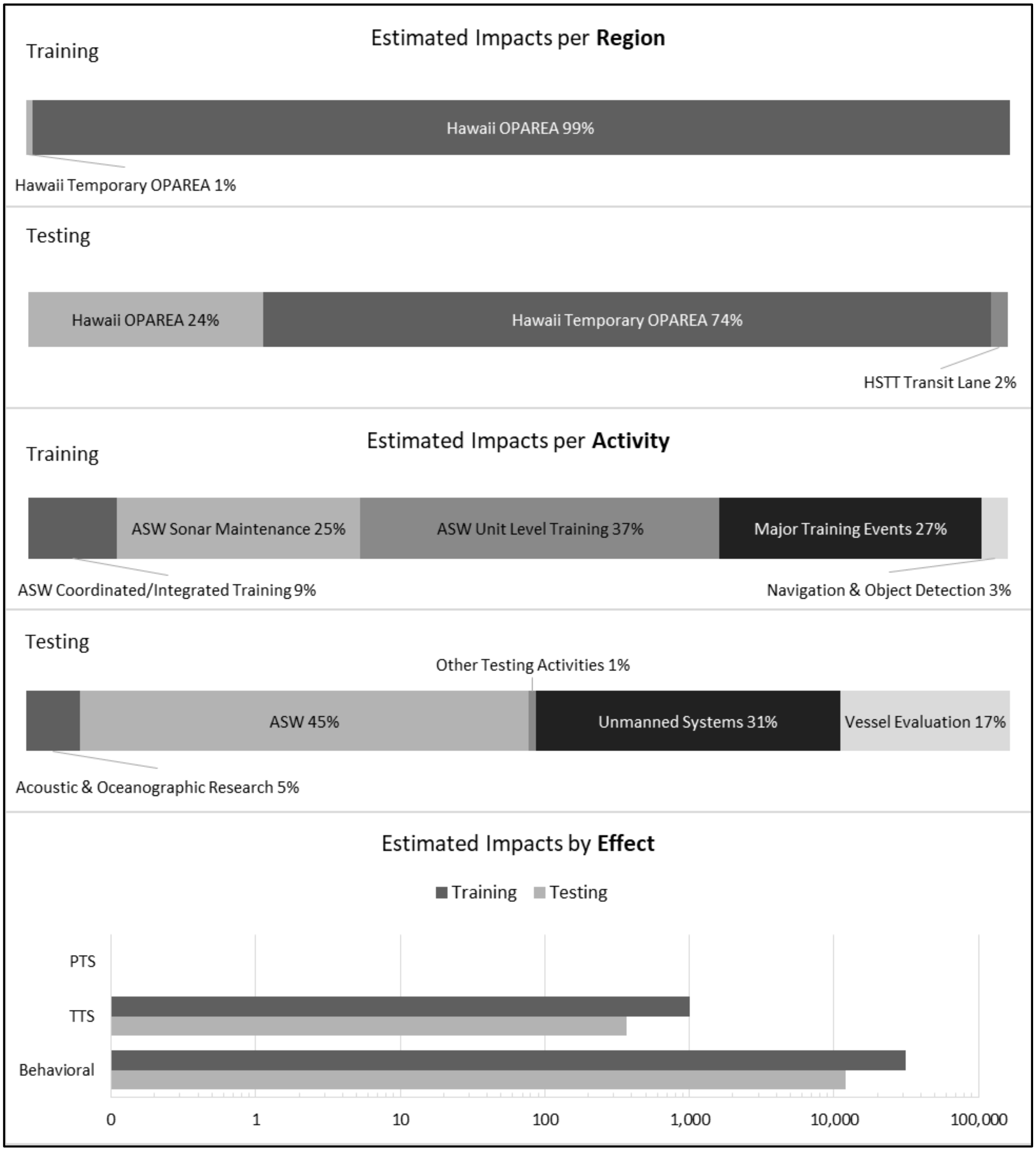


Figure 3.7-50: Fraser's Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

Killer Whales

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. See Figure 3.7-51 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-35).

As described for other 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 will 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 killer 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

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. See Figure 3.7-51 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-35).

As described for other 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 will 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 killer whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Figure 3.7-51: Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-35: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	29%	29%
Eastern North Pacific Offshore	25%	25%
Eastern North Pacific Transient/West Coast Transient	46%	46%

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. See Figure 3.7-52 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-36).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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.

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. See Figure 3.7-52 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-36).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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.

Figure 3.7-52: Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-36: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	26%	29%
Eastern North Pacific Offshore	26%	25%
Eastern North Pacific Transient/West Coast Transient	48%	46%

Long-Beaked Common Dolphins

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

Long-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 1. See Figure 3.7-53 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

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 will 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 long-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

Long-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. See Figure 3.7-53 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

As described for other 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 will 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 long-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.

Figure 3.7-53: Long-Beaked Common Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California Stock. ASW = Anti-Submarine Warfare

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

Long-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. See Figure 3.7-54 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 long-beaked common dolphins incidental to those activities.

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

Long-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. See Figure 3.7-54 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

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

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 long-beaked common dolphins incidental to those activities.

Figure 3.7-54: Long-Beaked Common Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California Stock. ASW = Anti-Submarine Warfare

Melon-Headed Whales

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

Melon-headed 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. See Figure 3.7-55 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-37).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for melon-headed whales identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not routinely conduct anti-submarine warfare activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training exercises. However, sound from sonar or other transducers could still expose animals within the melon-headed whale small and resident population area identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, melon-headed whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on melon-headed whale natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015a).

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 melon-headed 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

Melon-headed 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. See Figure 3.7-55 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-37).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for melon-headed whales identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not routinely conduct antisubmarine warfare activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the melon-headed whale small and resident population area identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, melon-headed whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on melon-headed whale natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015a).

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 melon-headed whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

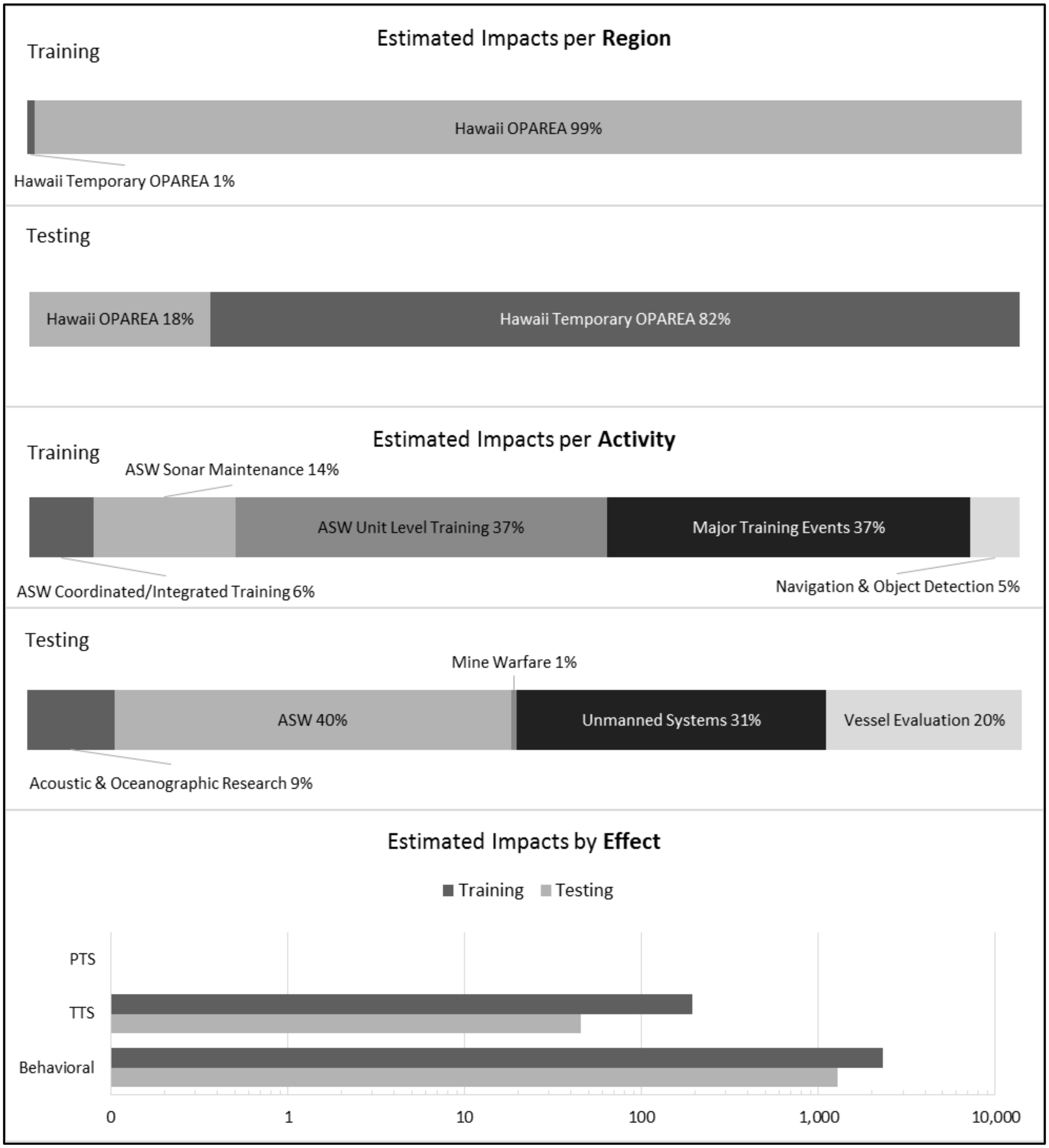


Figure 3.7-55: Melon-Headed Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-37: Estimated Impacts on Individual Melon-Headed Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian Islands	93%	87%
Kohala Resident	7%	13%

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

Melon-headed 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. See Figure 3.7-56 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-38).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 melon-headed whales incidental to those activities.

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

Melon-headed 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. See Figure 3.7-56 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-38).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 melon-headed whales incidental to those activities.

Figure 3.7-56: Melon-Headed Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-38: Estimated Impacts on Individual Melon-Headed Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian Islands	93%	88%
Kohala Resident	7%	12%

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. See Figure 3.7-57 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other 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 will 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 and TTS under Alternative 1. See Figure 3.7-57 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other 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 will 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.

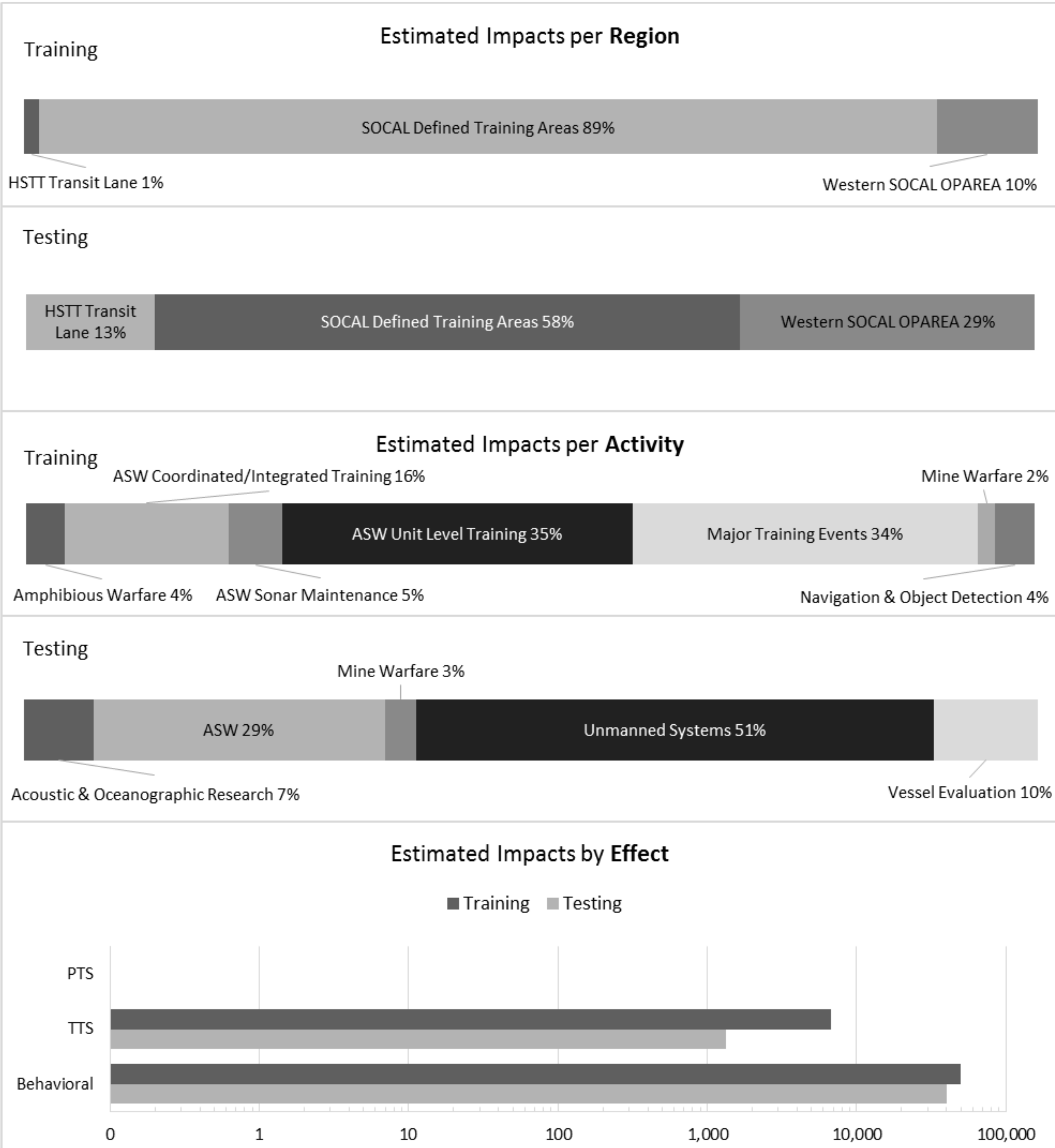


Figure 3.7-57: Northern Right Whale Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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. See Figure 3.7-58 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 and TTS under Alternative 2. See Figure 3.7-58 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 northern right whale dolphins incidental to those activities.

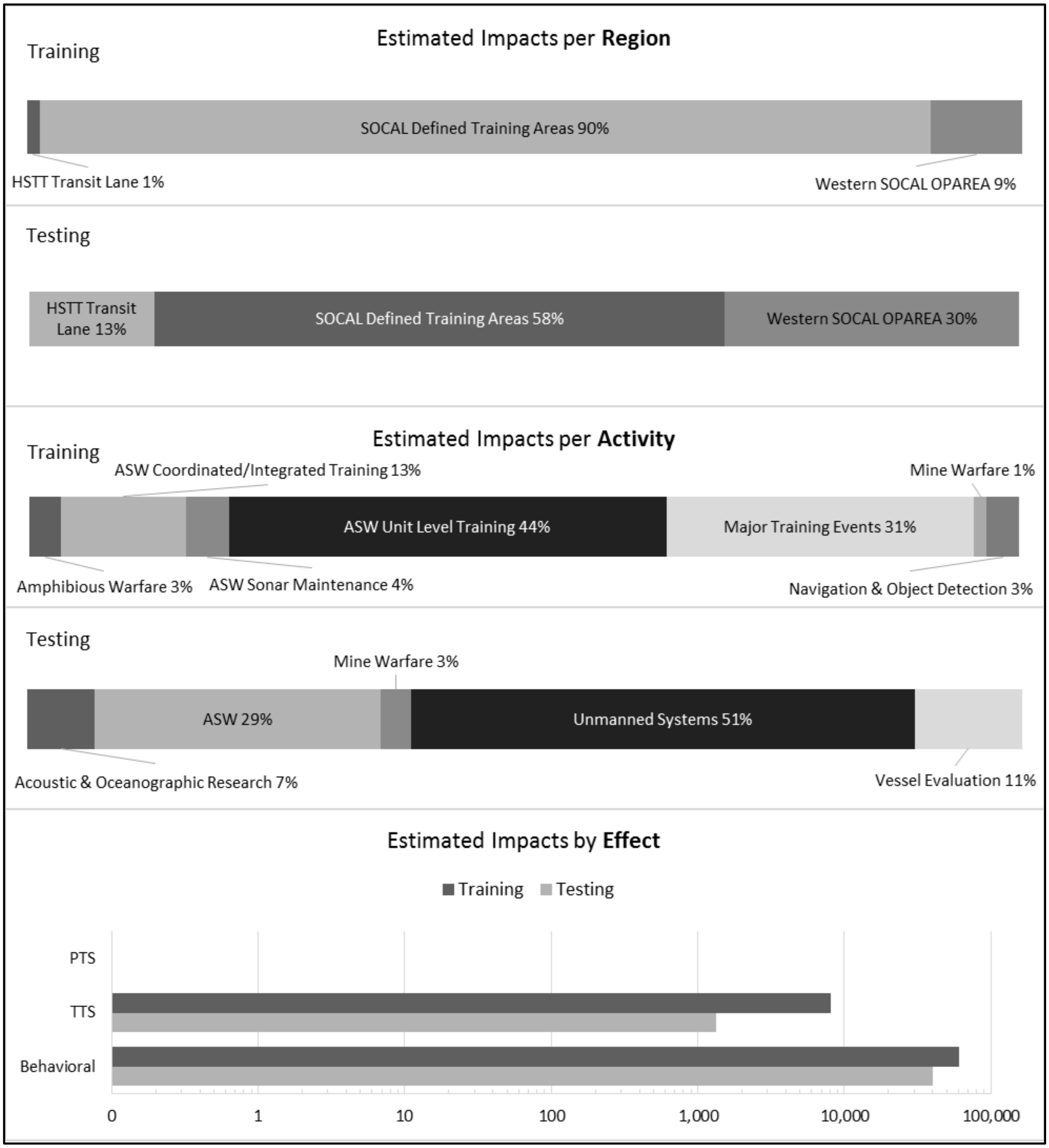


Figure 3.7-58: Northern Right Whale Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

Pantropical Spotted Dolphins

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

Pantropical spotted 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. See Figure 3.7-59 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-39).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Three small and resident population areas for pantropical spotted dolphins identified by Baird et al. (2015a) are within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training exercises. However, sound from sonar or other transducers could still expose animals within the identified pantropical spotted dolphin small and resident population areas identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, pantropical spotted dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on pantropical spotted dolphin natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015a).

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 pantropical spotted 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

Pantropical spotted 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. See Figure 3.7-59 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-39).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Three small and resident population areas for pantropical spotted dolphins identified by Baird et al. (2015a) are within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the identified pantropical spotted dolphin small and resident population areas identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, pantropical spotted dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on pantropical spotted dolphin natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015a).

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 pantropical spotted dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

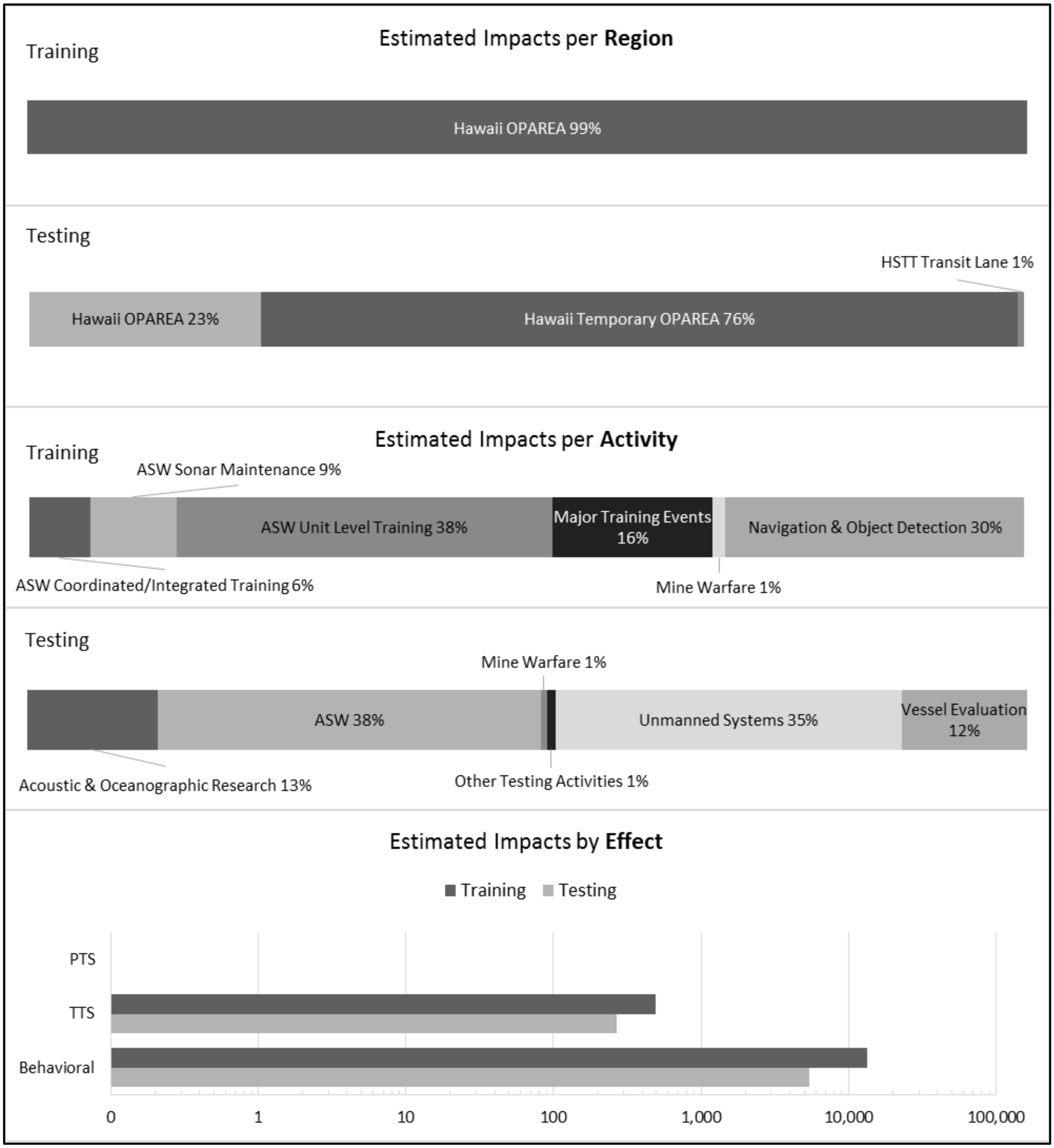


Figure 3.7-59: Pantropical Spotted Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-39; Estimated Impacts on Individual Pantropical Spotted Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
4-Island	2%	8%
Oahu	30%	4%
Hawaii Pelagic	49%	64%
Hawaii Island	19%	25%

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

Pantropical spotted 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. See Figure 3.7-60 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-40).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 pantropical spotted dolphins incidental to those activities.

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

Pantropical spotted 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. See Figure 3.7-60 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-40).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 pantropical spotted dolphins incidental to those activities.

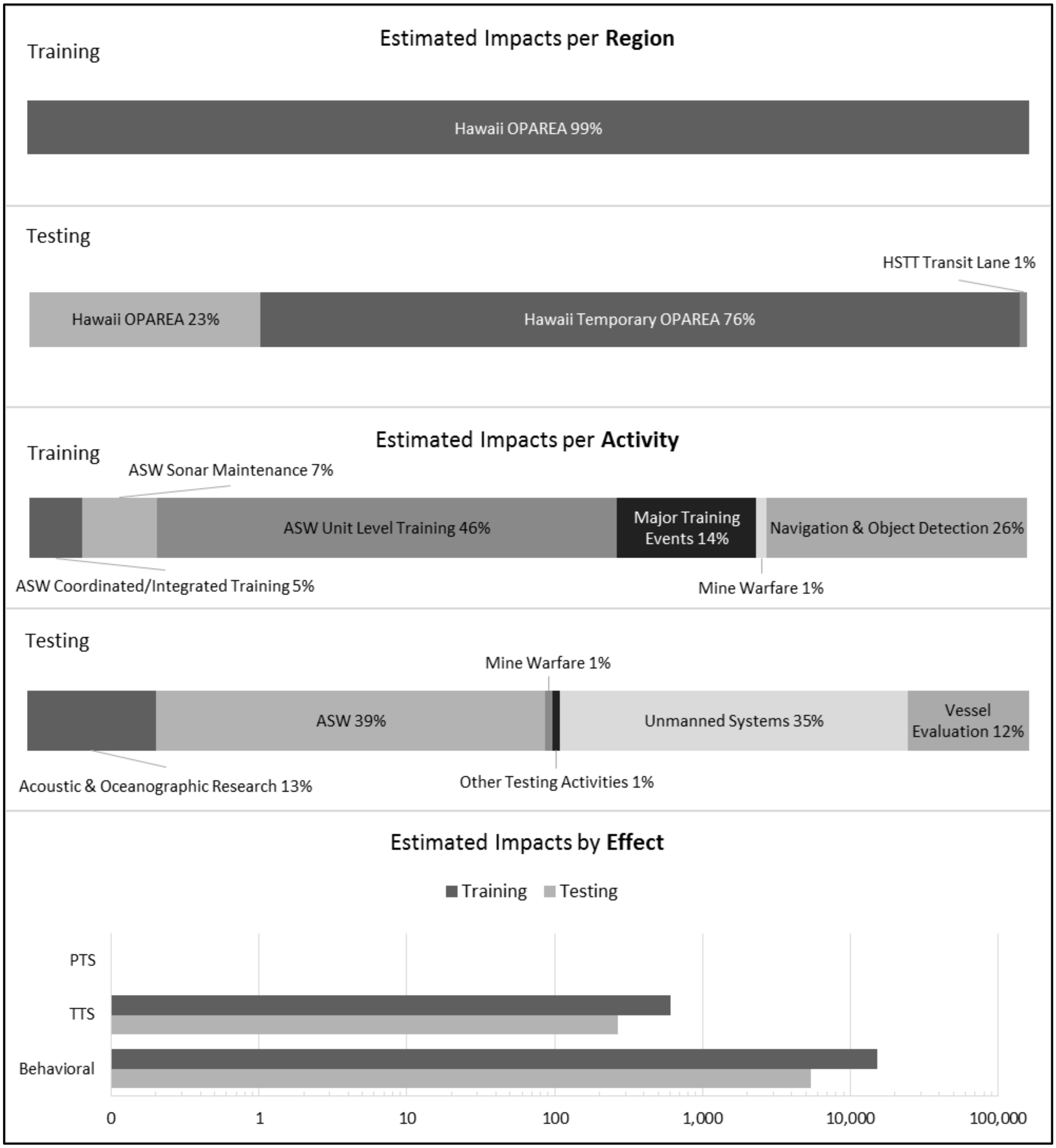


Figure 3.7-60: Pantropical Spotted Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-40: Estimated Impacts on Individual Pantropical Spotted Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
4-Island	2%	8%
Oahu	26%	4%
Hawaii Pelagic	53%	64%
Hawaii Island	19%	25%

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. See Figure 3.7-61 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other 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 will 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 and TTS under Alternative 1. See Figure 3.7-61 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other 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 will 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 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.

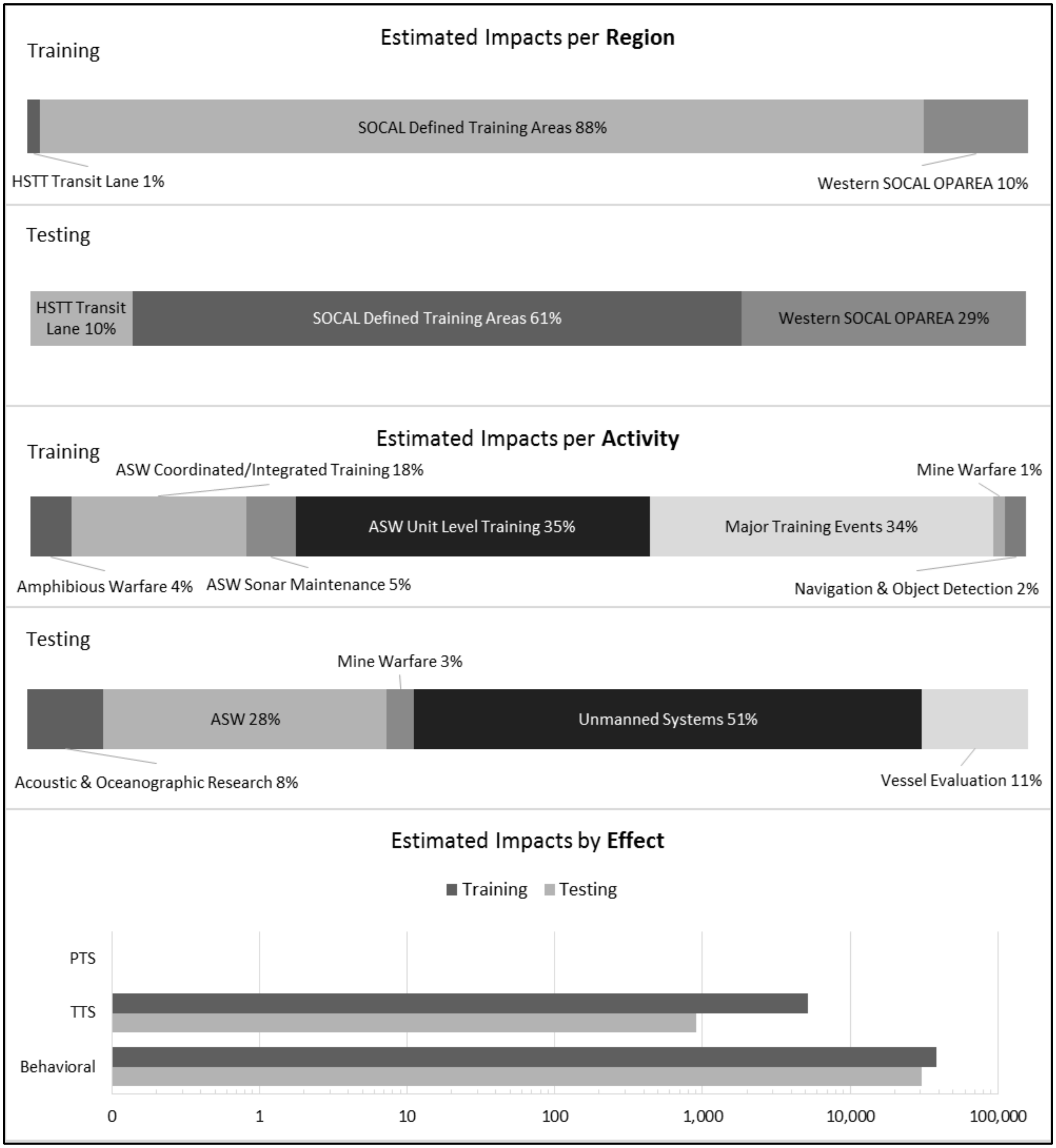


Figure 3.7-61: Pacific White-Sided Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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. See Figure 3.7-62 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 and TTS under Alternative 2. See Figure 3.7-62 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 Pacific white-sided dolphins incidental to those activities.

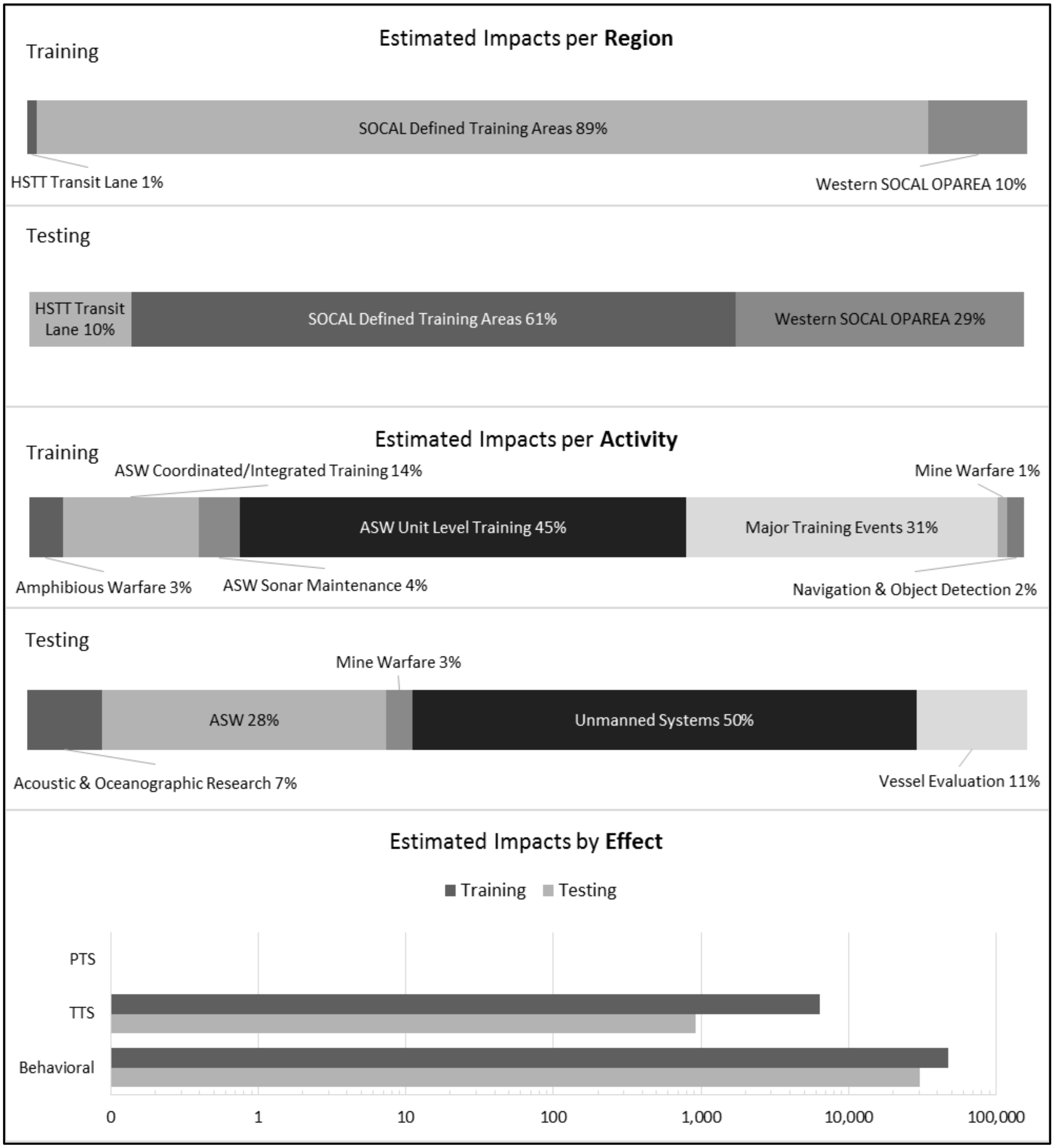


Figure 3.7-62: Pacific White-Sided Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

Pygmy Killer Whales

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

Pygmy 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. See Figure 3.7-63 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-41).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for pygmy killer whales identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training exercises. However, sound from sonar or other transducers could still expose animals within the pygmy killer whale small and resident population area identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, pygmy killer whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on pygmy killer whale natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015a).

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 pygmy killer 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

Pygmy 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. See Figure 3.7-63 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-41).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for pygmy killer whales identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the pygmy killer whale small and resident population area identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, pygmy killer whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on pygmy killer whale natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015a).

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 pygmy killer whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

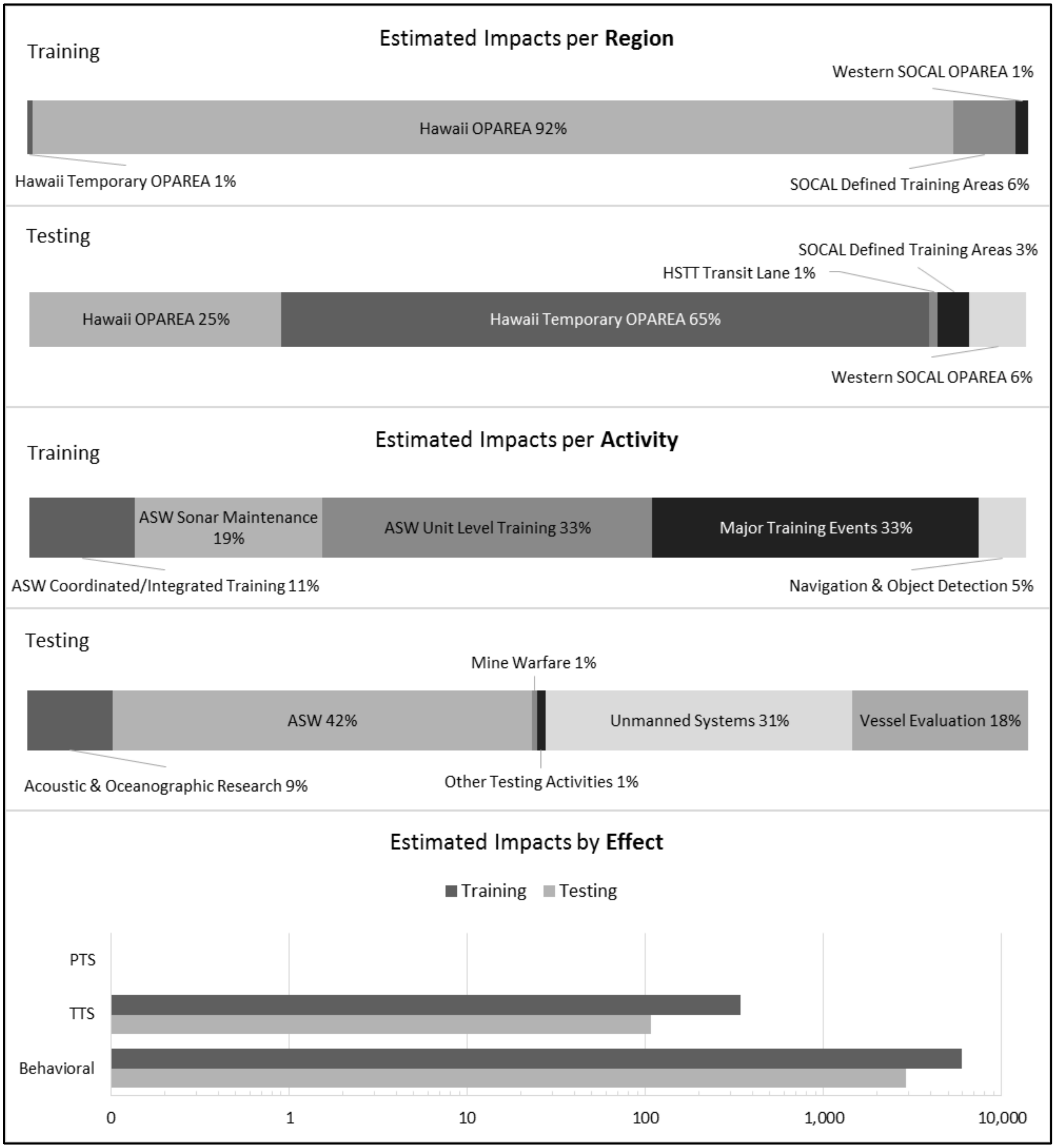


Figure 3.7-63: Pygmy Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-41: Estimated Impacts on Individual Pygmy Killer Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	93%	90%
Tropical	7%	10%

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

Pygmy killer whale 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. See Figure 3.7-64 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-42).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 pygmy killer whales incidental to those activities.

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

Pygmy 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. See Figure 3.7-64 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-42).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 pygmy killer whales incidental to those activities.

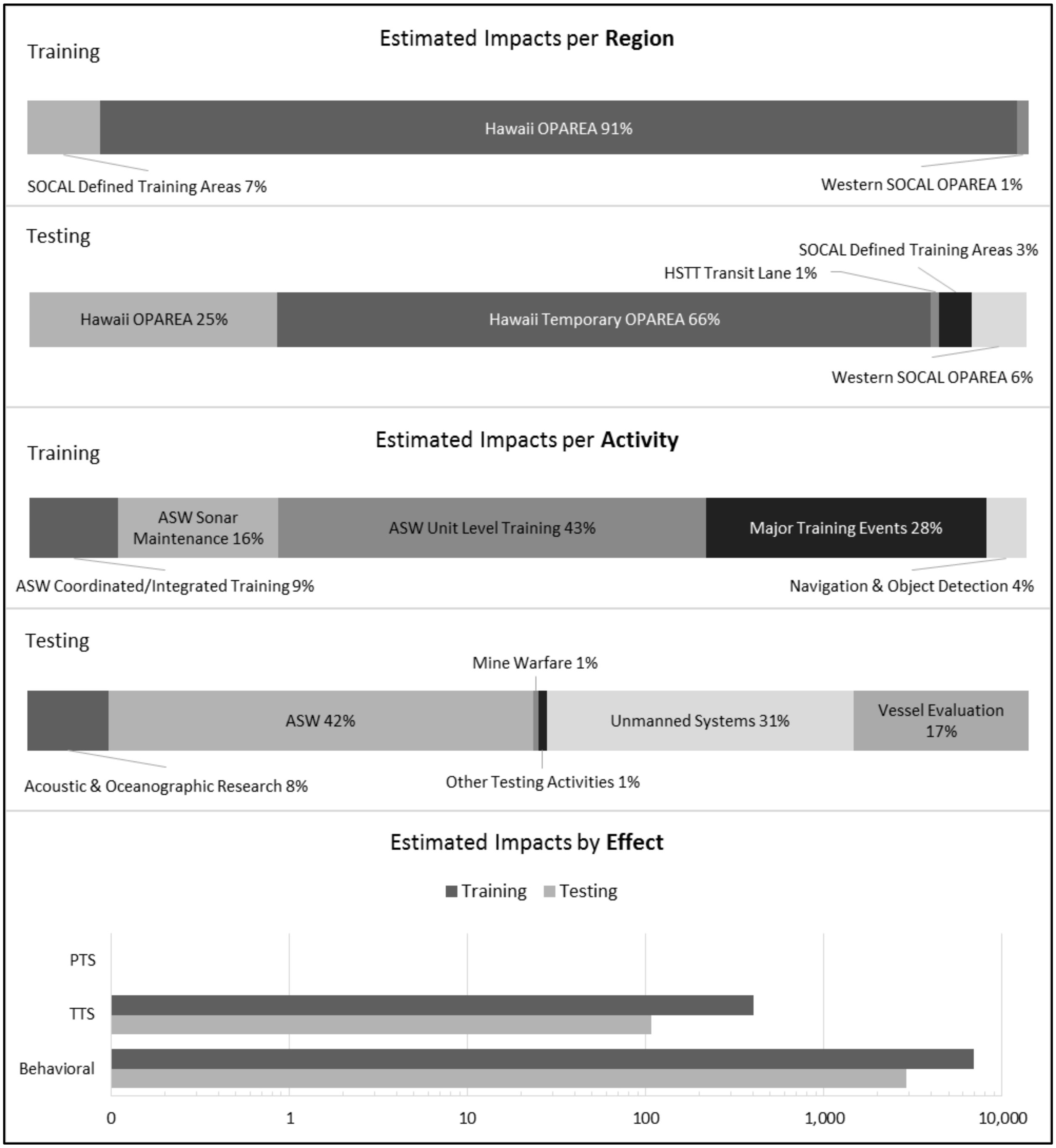


Figure 3.7-64: Pygmy Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-42: Estimated Impacts on Individual Pygmy Killer Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	92%	90%
Tropical	8%	10%

Risso's Dolphins

Impacts from Sonar and Other Transducers Under Alternative 1 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 1. See Figure 3.7-65 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-43).

As described for other 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 will 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 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.

Impacts from Sonar and Other Transducers Under Alternative 1 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 1. See Figure 3.7-65 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-43).

As described for other 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 will 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 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.

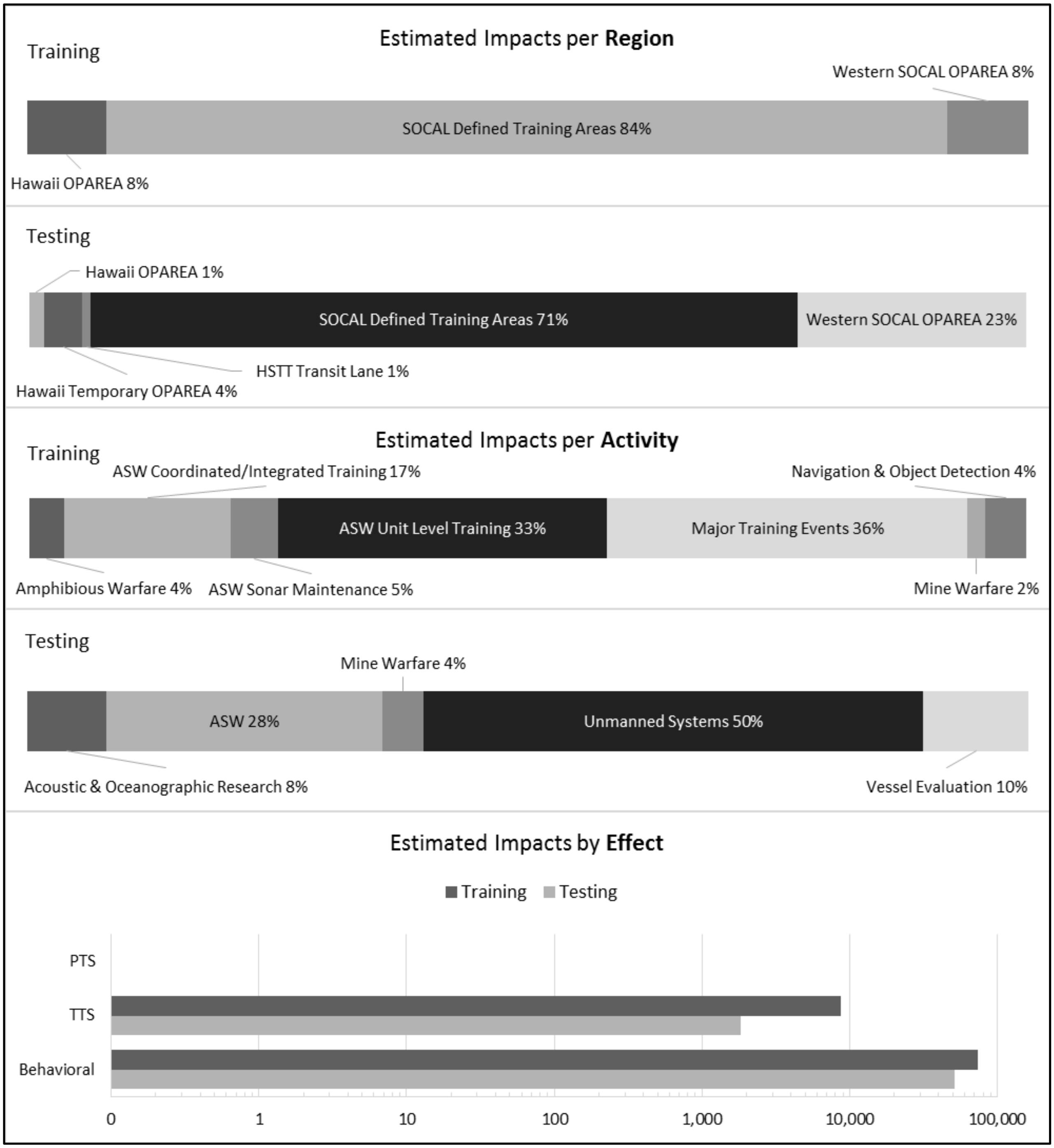


Figure 3.7-65: Risso's Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-43: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	8%	5%
California, Oregon, & Washington	92%	95%

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. See Figure 3.7-66 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-44).

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

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. See Figure 3.7-66 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-44).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 Risso's dolphins incidental to those activities.

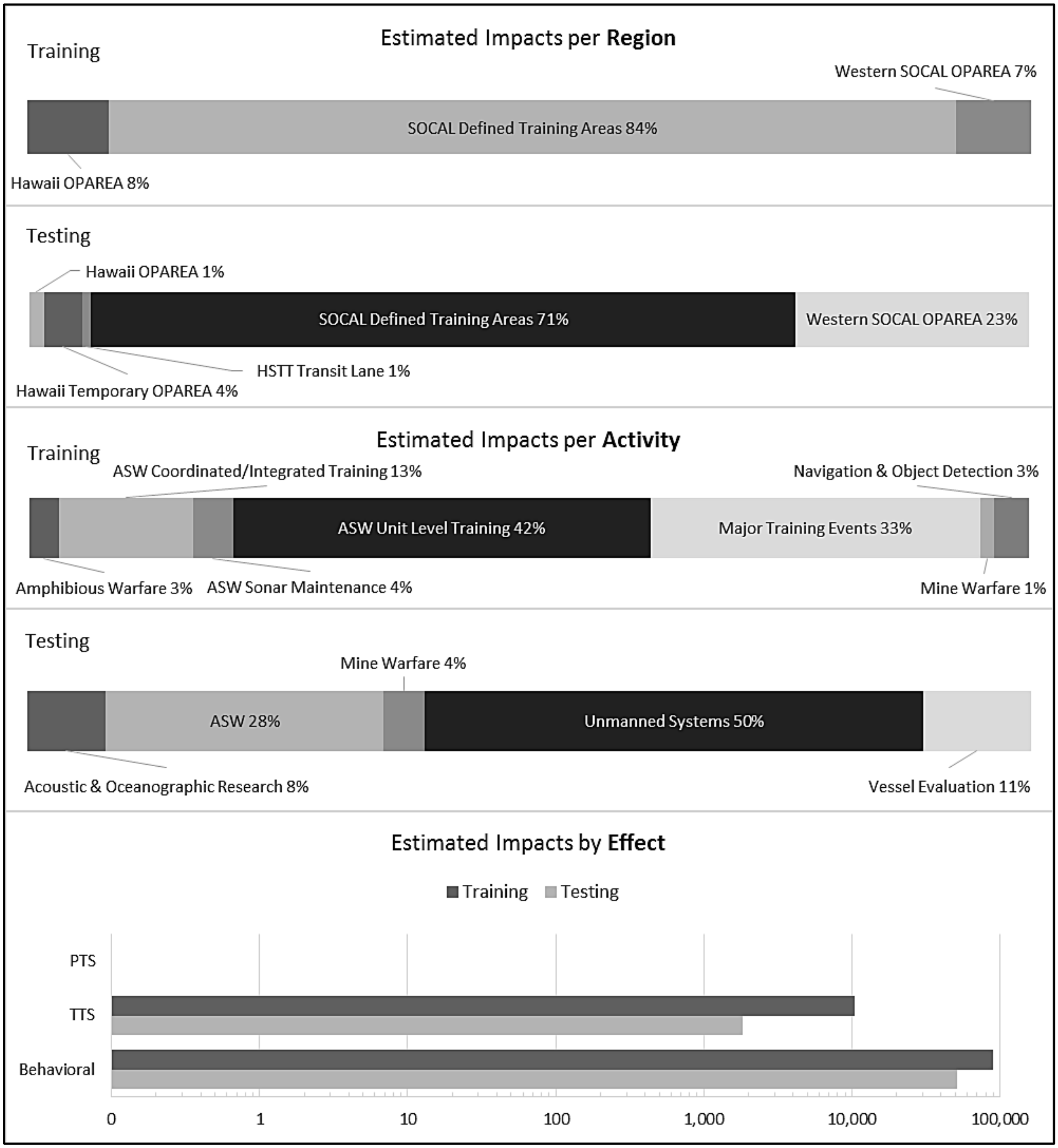


Figure 3.7-66: Risso's Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-44: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	8%	5%
California, Oregon, & Washington	92%	95%

Rough-Toothed Dolphins

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

Rough-toothed 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. See Figure 3.7-67 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A small and resident population area for rough-toothed dolphins identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified small and resident population area only takes up a very small portion Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration if it did occur. The sound from sonar or other transducers could still expose animals within the identified rough-toothed dolphin small and resident population area identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, rough-toothed dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on rough-toothed dolphin natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015a).

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 rough-toothed 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

Rough-toothed 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. See Figure 3.7-67 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A small and resident population area for rough-toothed dolphins identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified small and resident population area only takes up a very small portion Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration if it did occur. The sound from sonar or other transducers could still expose animals within the identified rough-toothed dolphin small and resident population area identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, rough-toothed dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on rough-toothed dolphin natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015a).

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 rough-toothed dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

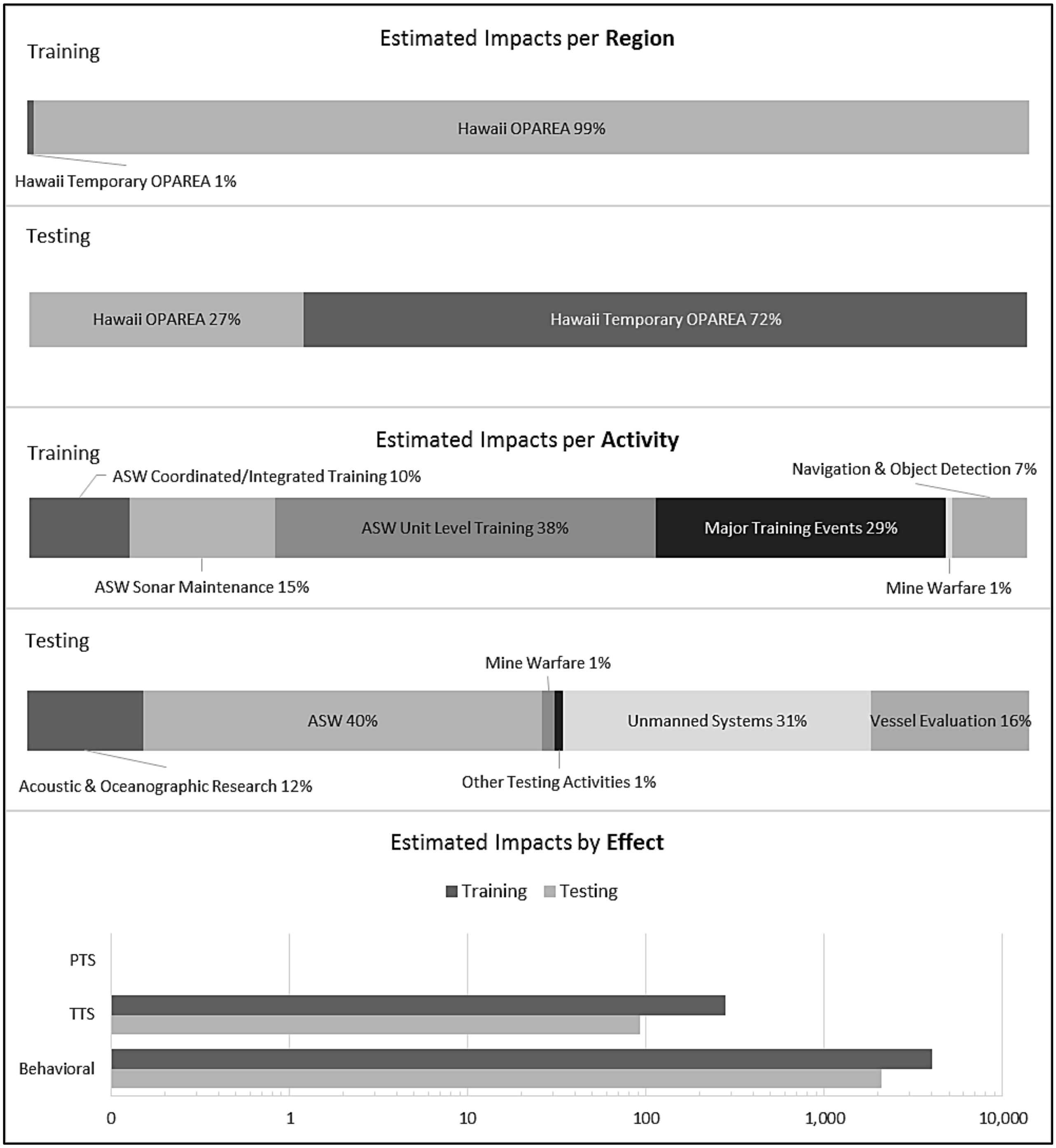


Figure 3.7-67: Rough-Toothed Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

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

Rough-toothed 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. See Figure 3.7-68 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 rough-toothed dolphins incidental to those activities.

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

Rough-toothed 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. See Figure 3.7-68 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 rough-toothed dolphins incidental to those activities.

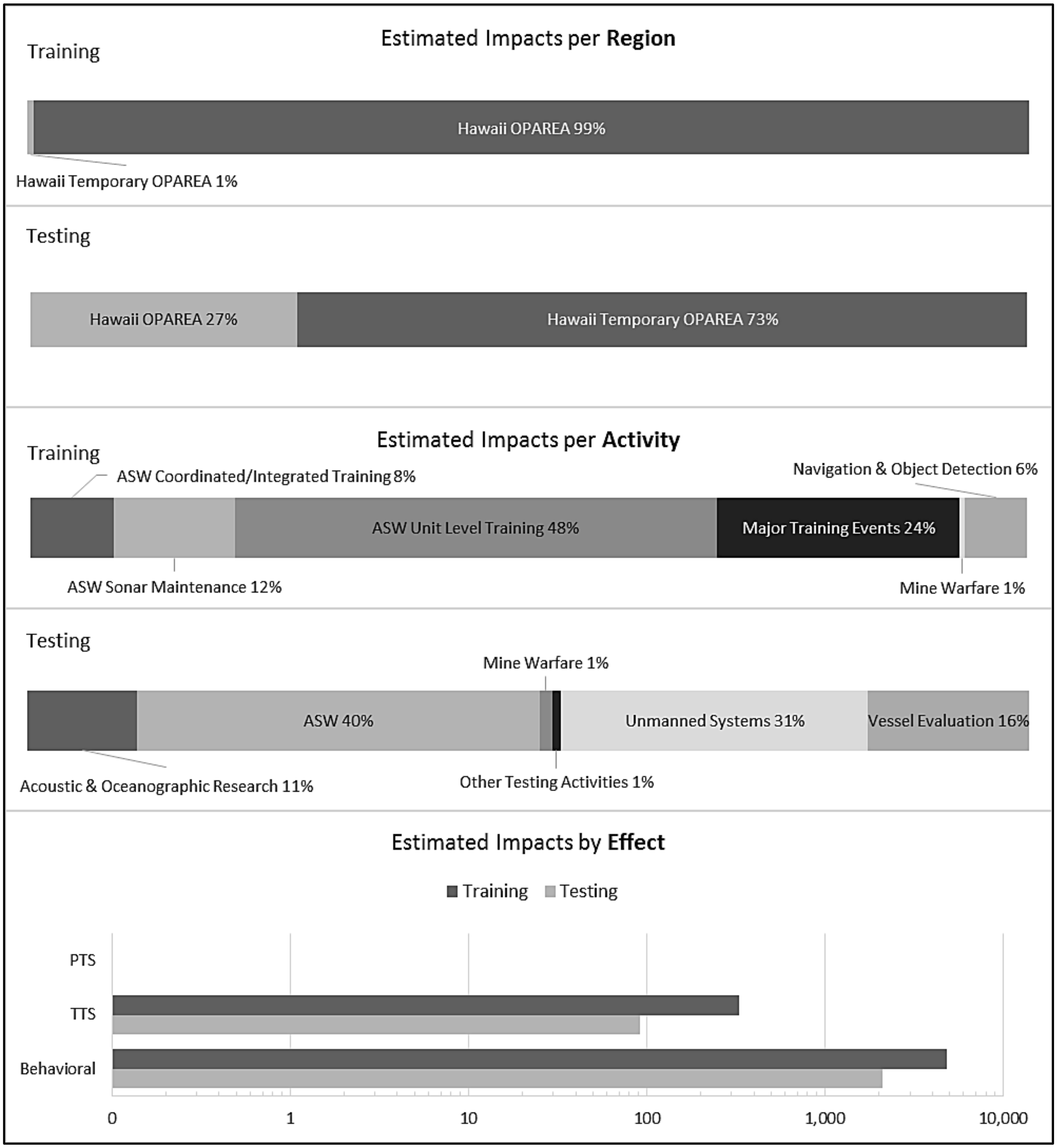


Figure 3.7-68: Rough-Toothed Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

Short-Beaked Common Dolphin

<u>Impacts from Sonar and Other Transducers Under Alternative 1 for Training Activities</u>

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, TTS, and PTS under Alternative 1. See Figure 3.7-69 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other 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 threshold shift. 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 will 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.

<u>Impacts from Sonar and Other Transducers Under Alternative 1 for Testing Activities</u>

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. See Figure 3.7-69 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other 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 will 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.

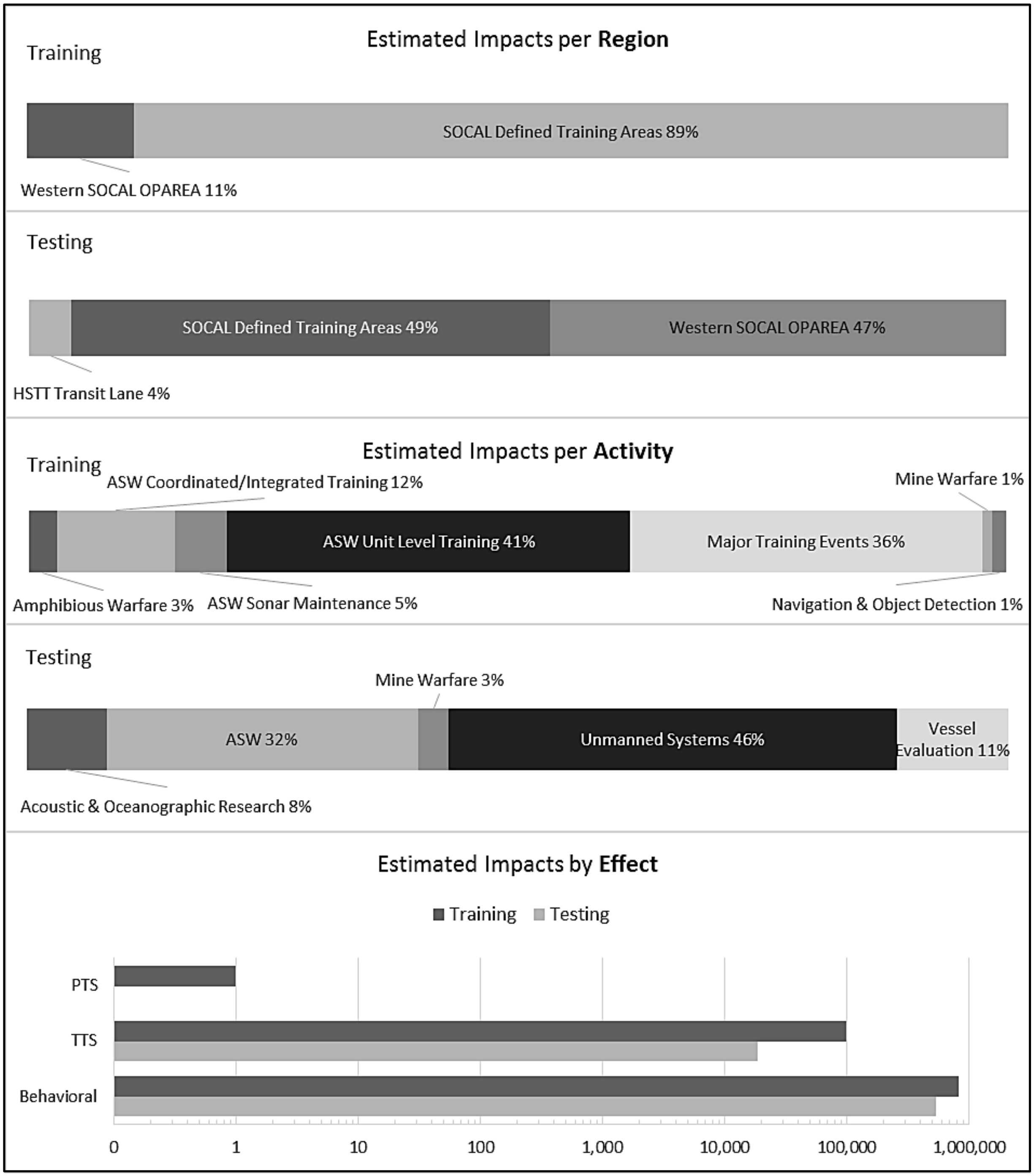


Figure 3.7-69: Short-Beaked Common Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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, TTS, and PTS under Alternative 2. See Figure 3.7-70 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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. See Figure 3.7-70 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 short-beaked common dolphins incidental to those activities.

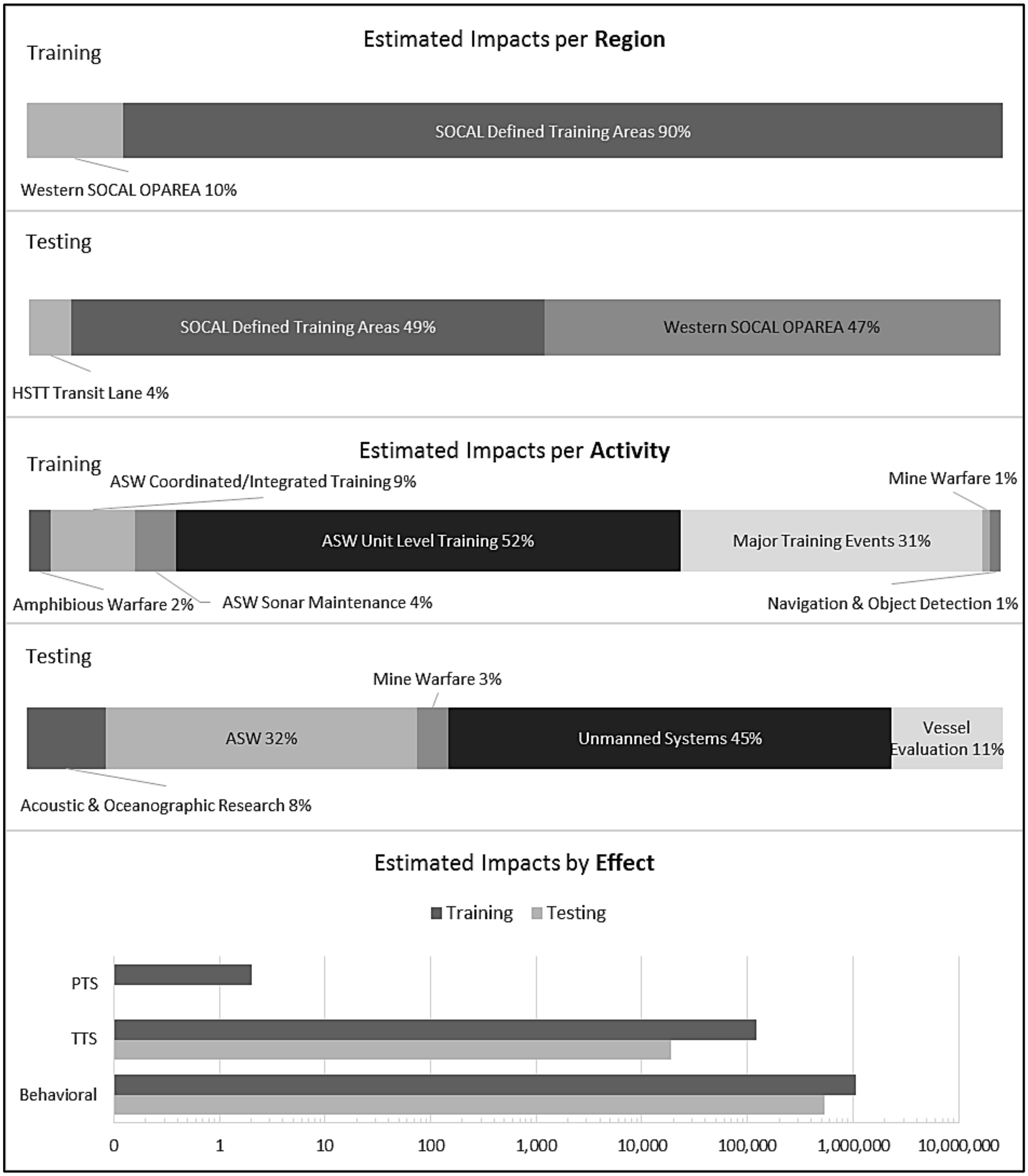


Figure 3.7-70: Short-Beaked Common Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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 and TTS under Alternative 1. See Figure 3.7-71 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-45).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for short-finned pilot whales identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the short-finned pilot whale small and resident population area identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, short-finned pilot whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on short-finned pilot whale natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015a).

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. See Figure 3.7-71 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-45).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for short-finned pilot whales identified by Baird et al. (2015a) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the short-finned pilot whale small and resident population area identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, short-finned pilot whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on short-finned pilot whale natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015a).

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.

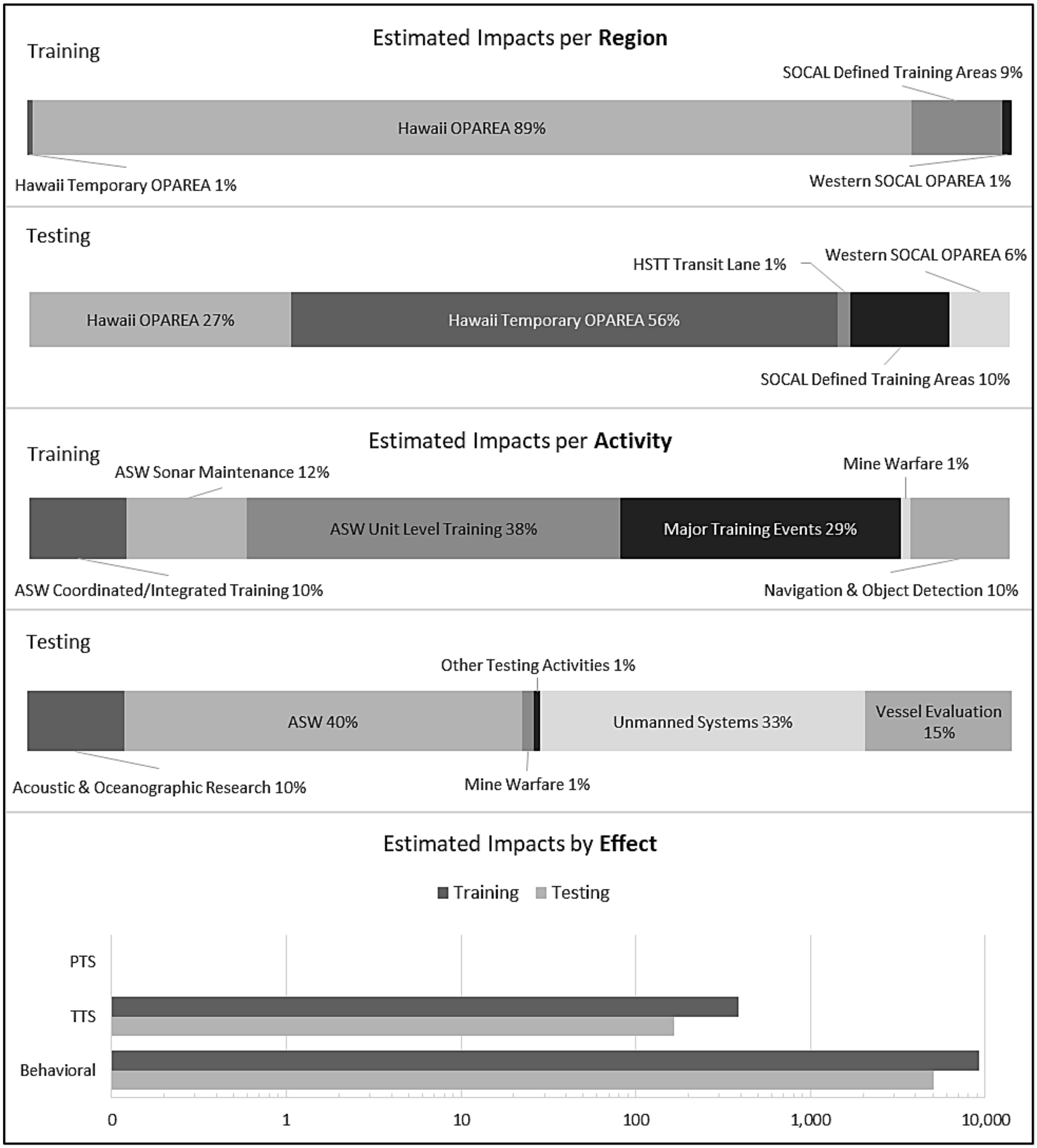


Figure 3.7-71: Short-Finned Pilot Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-45: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	90%	82%
California, Oregon, & Washington	10%	18%

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 and TTS under Alternative 2. See Figure 3.7-72 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-46).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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. See Figure 3.7-72 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-46).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 short-finned pilot whales incidental to those activities.

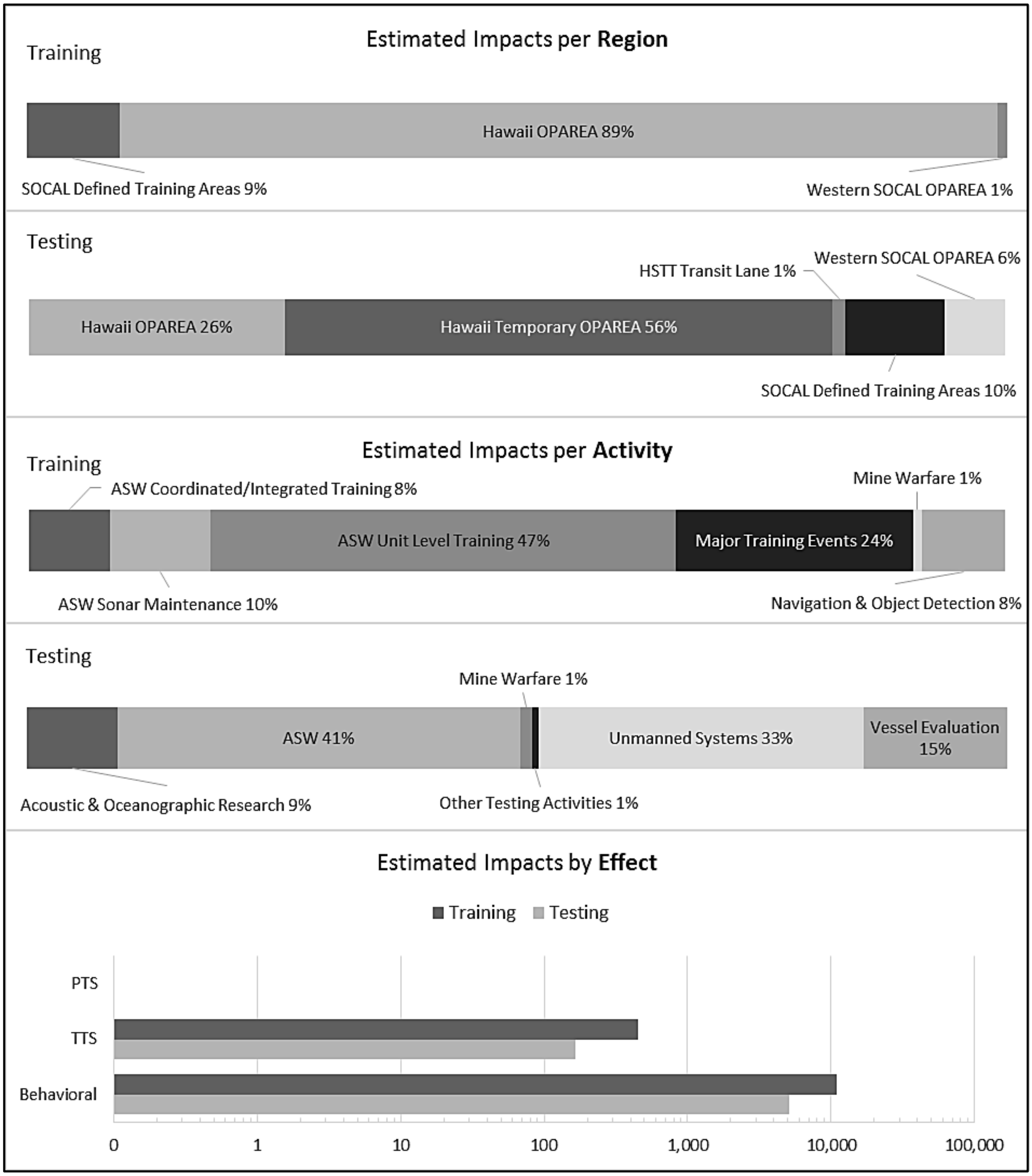


Figure 3.7-72: Short-Finned Pilot Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-46: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	89%	82%
California, Oregon, & Washington	11%	18%

Spinner Dolphins

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

Spinner 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. See Figure 3.7-73 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-47).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Five small and resident population areas for spinner dolphins identified by Baird et al. (2015a) are within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training exercises. However, sound from sonar or other transducers could still expose animals within the identified spinner dolphin small and resident population areas identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, spinner dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on spinner dolphin natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015a).

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 spinner 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

Spinner 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. See Figure 3.7-73 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-47).

As described for other 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Five small and resident population areas for spinner dolphins identified by Baird et al. (2015a) are within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the identified spinner dolphin small and resident population areas identified by Baird et al. (2015a) and some impacts on behavior could occur. As discussed above, spinner dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on spinner dolphin natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015a).

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 spinner dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

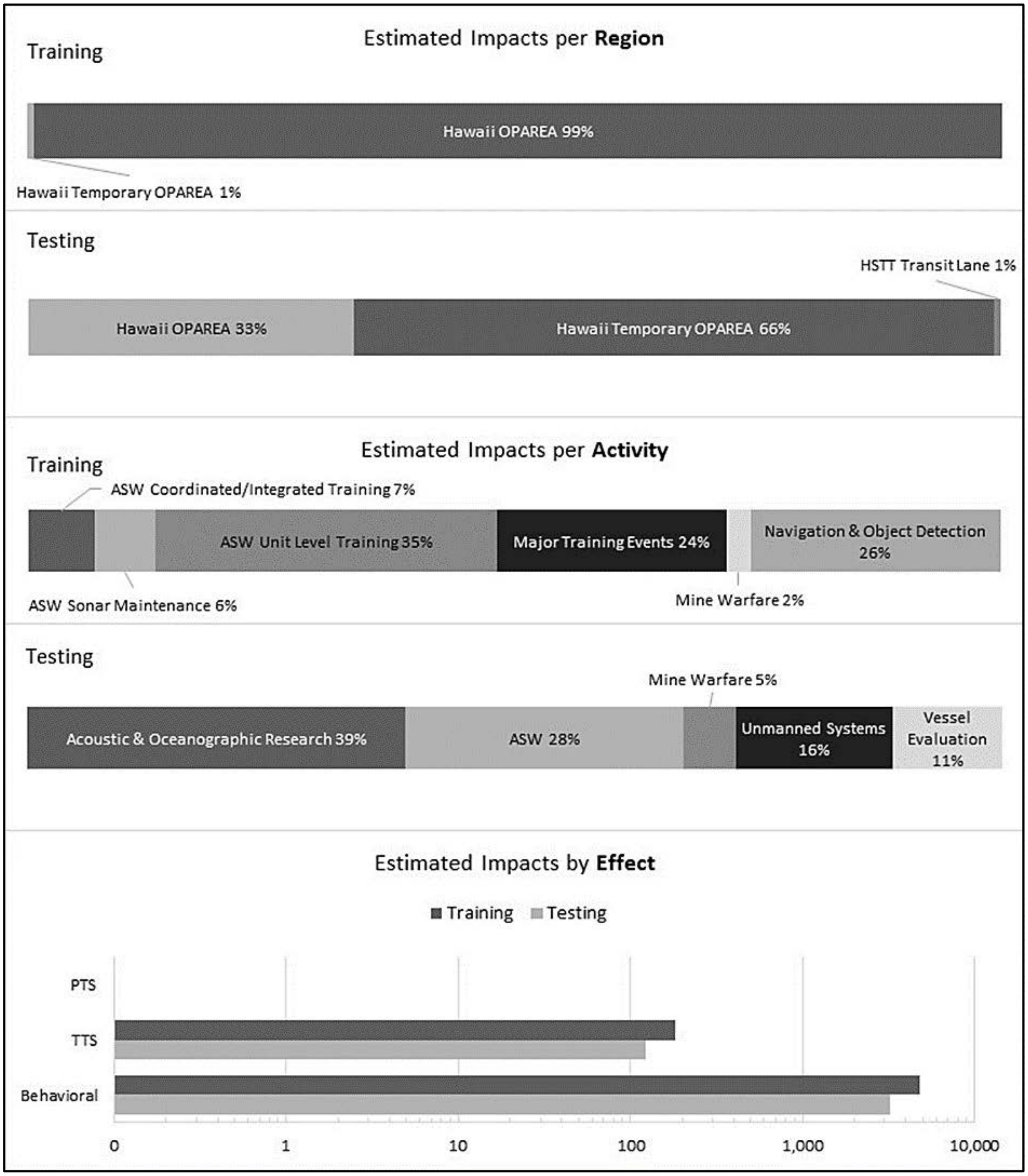


Figure 3.7-73: Spinner Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-47: Estimated Impacts on Individual Spinner Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Kauai and Niihau	6%	43%
Hawaii Pelagic	62%	41%
Hawaii Island	2%	6%
Oahu and 4-Island	30%	10%

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

Spinner 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. See Figure 3.7-74 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-48).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 spinner dolphins incidental to those activities.

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

Spinner 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. See Figure 3.7-74 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-48).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 spinner dolphins incidental to those activities.

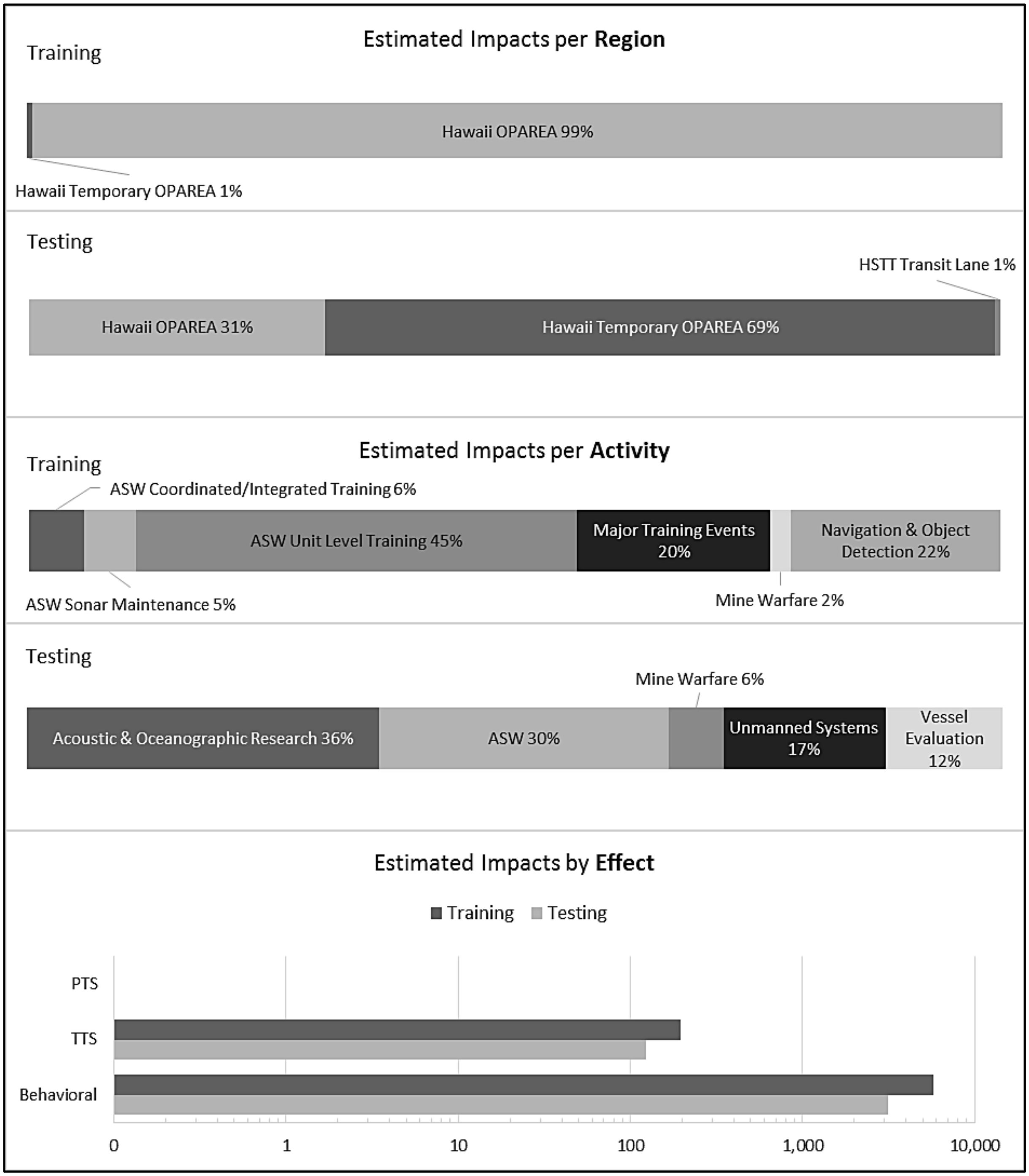


Figure 3.7-74: Spinner Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-48: Estimated Impacts on Individual Spinner Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Kauai and Niihau	6%	40%
Hawaii Pelagic	67%	43%
Hawaii Island	2%	6%
Oahu and 4-Island	25%	10%

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. See Figure 3.7-75 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-49).

As described for other 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 will 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 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. See Figure 3.7-75 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-49).

As described for other 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 will 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 striped dolphins incidental to those

activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

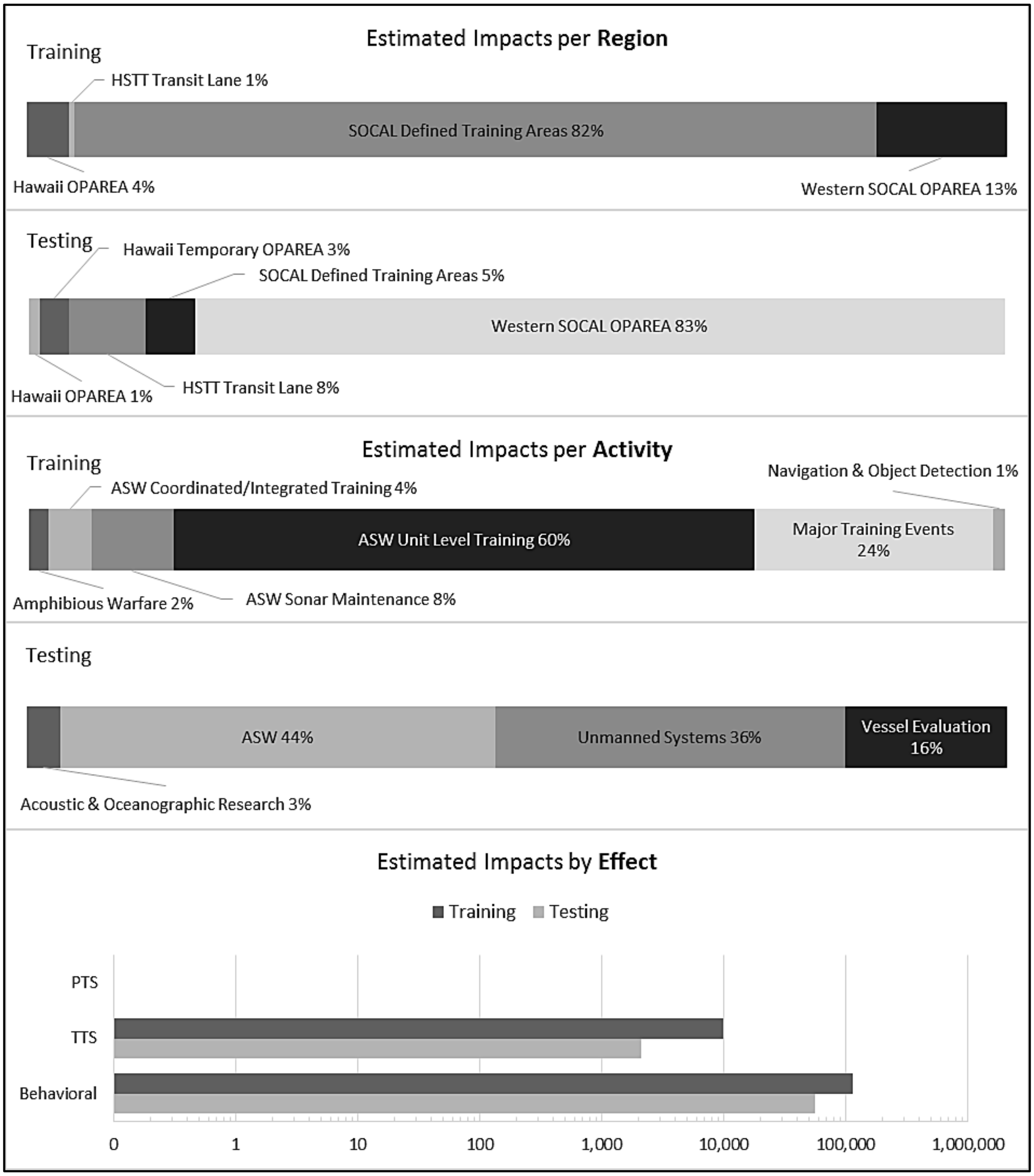


Figure 3.7-75: Striped Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-49: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	96%	96%
Hawaiian	4%	4%

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. See Figure 3.7-76 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-50).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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. See Figure 3.7-76 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 3.7-50).

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 striped dolphins incidental to those activities.

Figure 3.7-76: Striped Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-50: 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 per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	96%	96%
Hawaiian	4%	4%

Dall's Porpoises

Dall's porpoises are most likely to respond to exposures to sonar and other transducers with behavioral reactions or minor to moderate TTS that would fully recover quickly (i.e., a few minutes to a few hours). The quantitative analysis predicts a few PTS per year; however, as discussed above, odontocetes would likely avoid sound levels that could cause higher levels of TTS (> 20 dB) or PTS. 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). Dall's porpoises that do experience hearing loss (i.e., TTS or PTS) from sonar sounds may have a reduced ability to detect biologically important sounds until their hearing recovers. TTS would be recoverable and PTS would leave some residual hearing loss. During the period that a Dall's porpoise had hearing loss, biologically important sounds could be more difficult to detect or interpret. Odontocetes, including Dall's porpoises, use echolocation clicks to find and capture prey. These echolocation clicks are at frequencies above 100 kHz in Dall's porpoises; therefore, echolocation is unlikely to be affected by a threshold shift at lower frequencies and should not affect a Dall's porpoise's ability to locate prey or rate of feeding. 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.

Research and observations on reactions to sound from sonar or other transducers are not available for Dall's porpoise. Another porpoise species, the harbor porpoise, is very sensitive to human-made sound and wary of human activity. It is assumed that Dall's porpoise is also more reactive than most other odontocetes and would avoid human-made sound and activities within a few kilometers. 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. Behavioral reactions from Dall's porpoises are more likely to be significant than in other species of odontocetes; however, most reactions estimated by the quantitative analysis are likely to be short-term and low to moderate severity.

Most estimated impacts are due to anti-submarine warfare activities, which could vary in duration and intensity. Anti-submarine warfare unit level events and maintenance typically last for a matter of a few hours and involve a limited amount of sonar use so that significant responses would be less likely than with longer and more intense events. Coordinated/integrated anti-submarine warfare events and major training exercises involve multiple sonar systems and can last for a period of days, making significant responses more likely. However, even a few minor to moderate TTS and 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.

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. See Figure 3.7-77 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described 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 threshold shift 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 will 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. See Figure 3.7-77 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described 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 threshold shift 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 will 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 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.

Figure 3.7-77: Dall's Porpoise Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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. See Figure 3.7-78 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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. See Figure 3.7-78 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 Dall's porpoises incidental to those activities.

Figure 3.7-78: Dall's Porpoise Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

Pinnipeds

Pinnipeds include phocid seals (true seals) and otariids (sea lions and fur seals).

Pinnipeds may be exposed to sound from sonar and other transducers associated with training 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 3.7.2.1.4, 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 pinnipeds are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers).

A few behavioral reactions in 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 3.7.3.1.1.5, 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 (see 3.7.3.1.1.5, Behavioral Reactions). If pinnipeds 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 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 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 threshold shift. 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 3.7.3.1.1.4 (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. 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 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 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 per year are unlikely to have any long-term consequences for that individual.

Guadalupe Fur Seals (Endangered Species Act-listed)

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

Guadalupe 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. See Figure 3.7-79 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Mexico stock.

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 will 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 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. See Figure 3.7-79 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Mexico stock.

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 will 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.

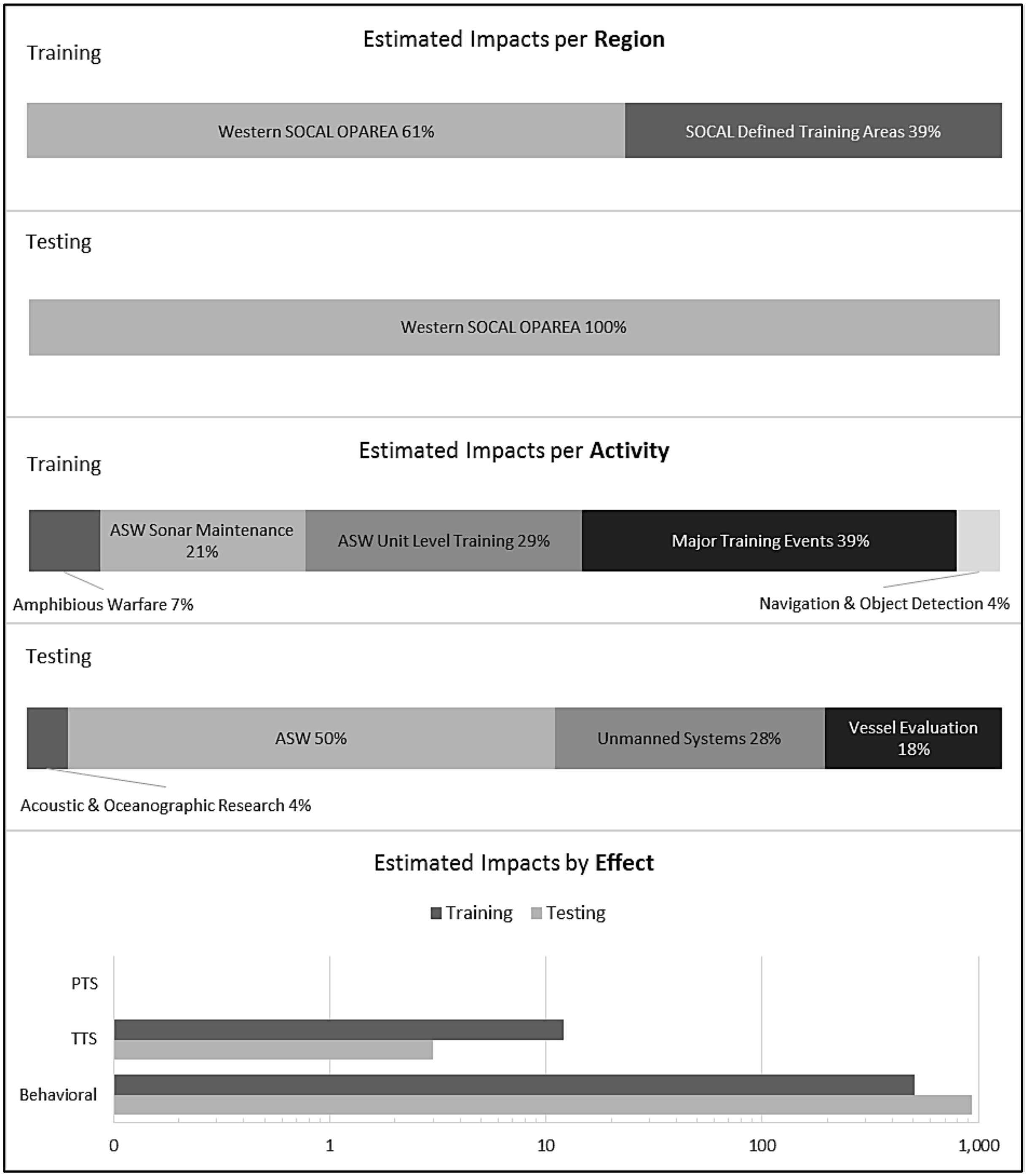


Figure 3.7-79: Guadalupe Fur Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Mexico Stock. ASW = Anti-Submarine Warfare

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

Guadalupe 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. See Figure 3.7-80 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Mexico stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 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. See Figure 3.7-80 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Mexico stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 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.

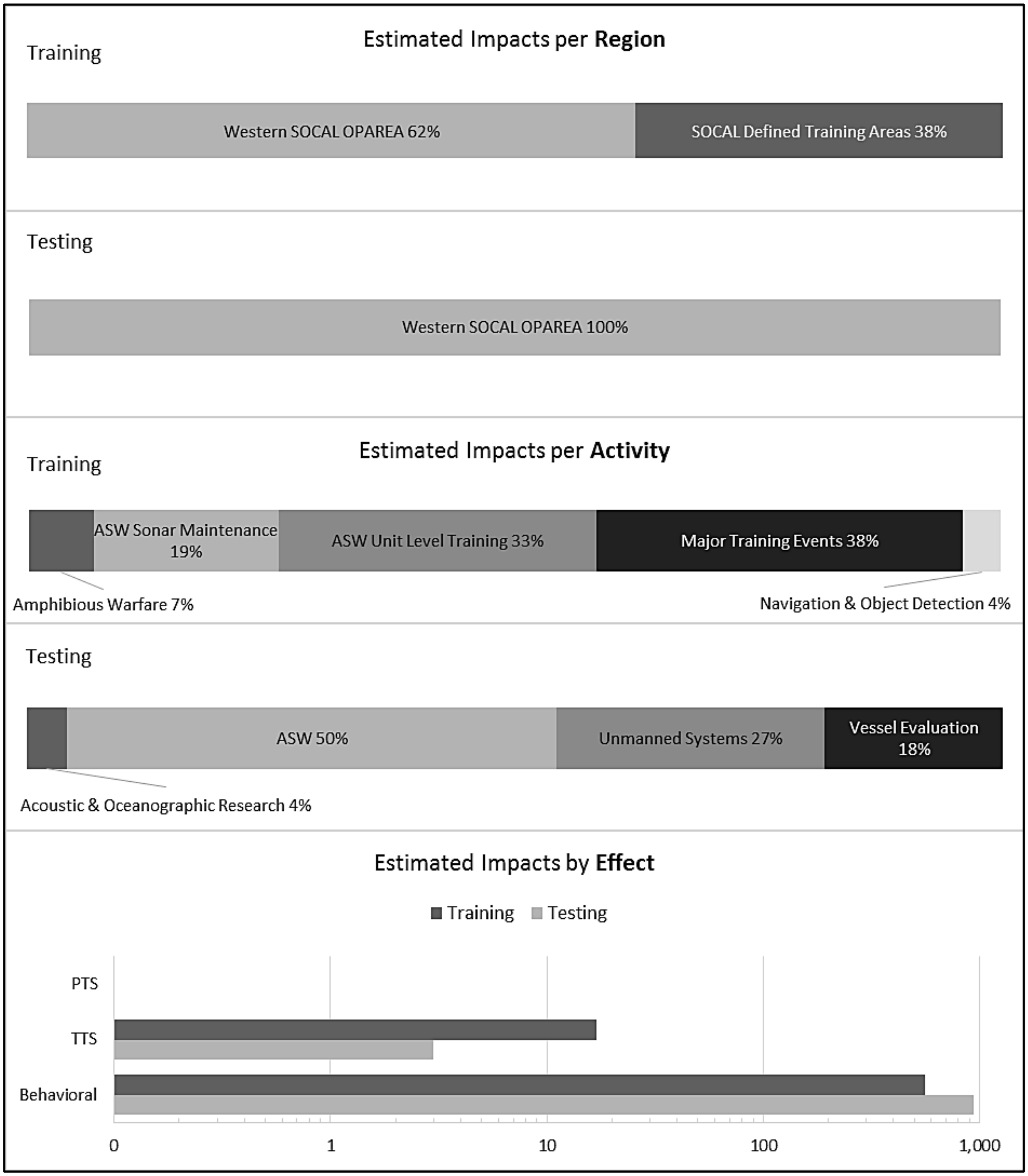


Figure 3.7-80: Guadalupe Fur Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Mexico Stock. ASW = Anti-Submarine Warfare

Hawaiian Monk Seals (Endangered Species Act-listed)

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

Hawaiian monk 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. See Figure 3.7-81 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

As discussed in Section 3.7.2.2.9 (Hawaiian Monk Seal), the Study Area does overlap the marine portions of the Hawaiian monk seal critical habitat and some limited use of sonar and other transducers does take place within these areas; however, the sound from sonar and other transducers would not affect the designated essential features (i.e., marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging).

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 Hawaiian monk 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 Hawaiian monk seals and would not affect Hawaiian monk seal critical habitats. 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

Hawaiian monk 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. See Figure 3.7-81 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

As discussed in Section 3.7.2.2.9 (Hawaiian Monk Seal), the Study Area does overlap the marine portions of the Hawaiian monk seal critical habitat and some limited use of sonar and other transducers does take place within these areas; however, the sound from sonar and other transducers would not affect the designated essential features (i.e., marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging).

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 Hawaiian monk 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 Hawaiian monk seals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Figure 3.7-81: Hawaiian Monk Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

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

Hawaiian monk 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. See Figure 3.7-82 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 Hawaiian monk 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 Hawaiian monk seals and would not affect Hawaiian monk seal critical habitats.

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

Hawaiian monk 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. See Figure 3.7-82 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 Hawaiian monk 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 Hawaiian monk seals and would not affect Hawaiian monk seal critical habitats.

Figure 3.7-82: Hawaiian Monk Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

Harbor Seals

Impacts from Sonar and Other Transducers Under Alternative 1 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 1. See Figure 3.7-83 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

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 will 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 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 Sonar and Other Transducers Under Alternative 1 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 and TTS under Alternative 1. See Figure 3.7-83 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

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 will 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 harbor seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Figure 3.7-83: Harbor Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent California Stock. ASW = Anti-Submarine Warfare

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. See Figure 3.7-84 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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 and TTS under Alternative 2. See Figure 3.7-84 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 harbor seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Figure 3.7-84: Harbor Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent California Stock. ASW = Anti-Submarine Warfare

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, TTS, and PTS under Alternative 1. See Figure 3.7-85 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

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 will 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. See Figure 3.7-85 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

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 will 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.

Figure 3.7-85: Northern Elephant Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent California Stock. ASW = Anti-Submarine Warfare

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, TTS, and PTS under Alternative 2. See Figure 3.7-86 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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. See Figure 3.7-86 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 Northern elephant seals incidental to those activities.

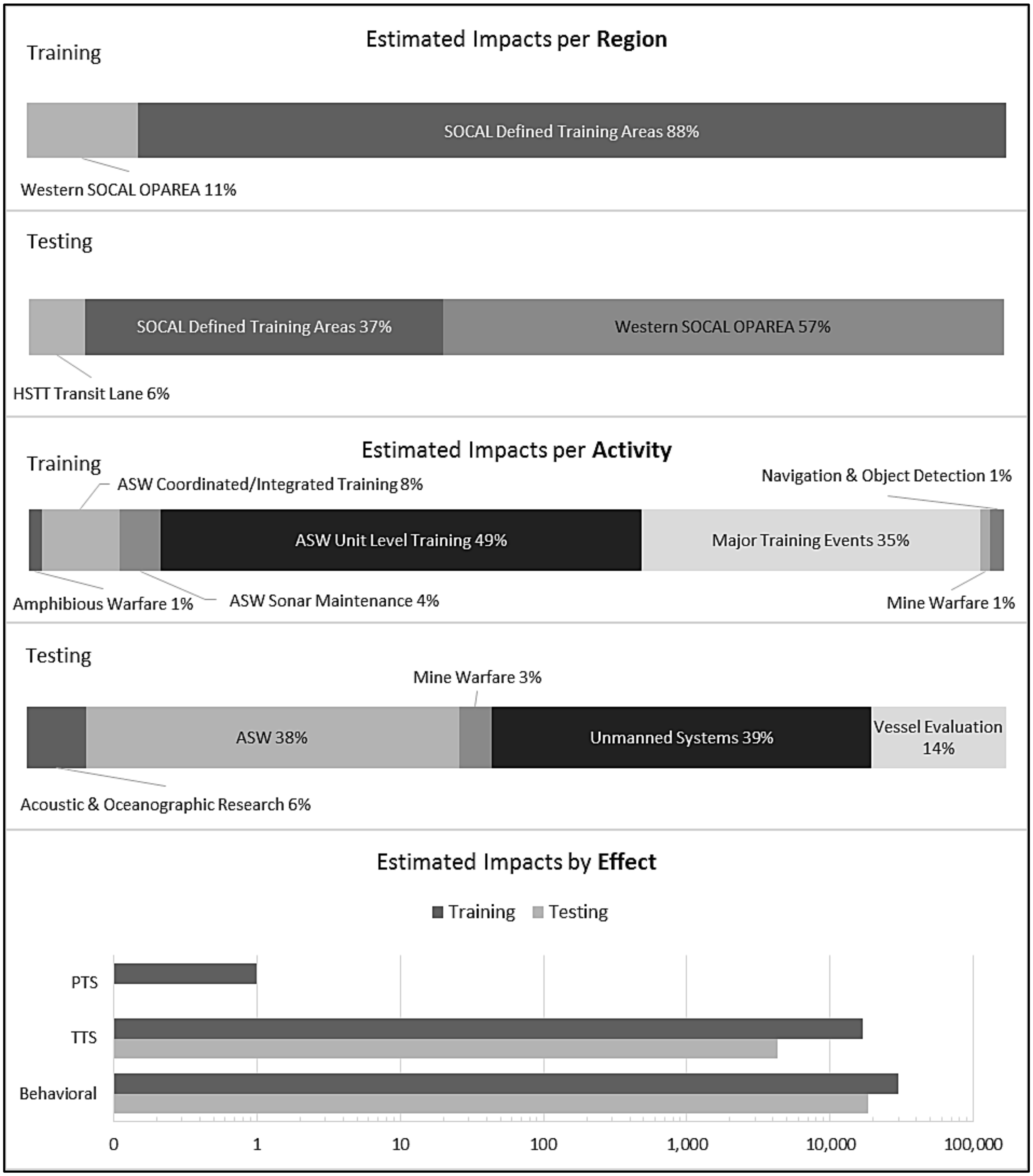


Figure 3.7-86: Northern Elephant Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent California Stock. ASW = Anti-Submarine Warfare

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. See Figure 3.7-87 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the U.S. stock.

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 will 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, TTS, and PTS under Alternative 1. See Figure 3.7-87 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the U.S. stock.

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. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. 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 will 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.

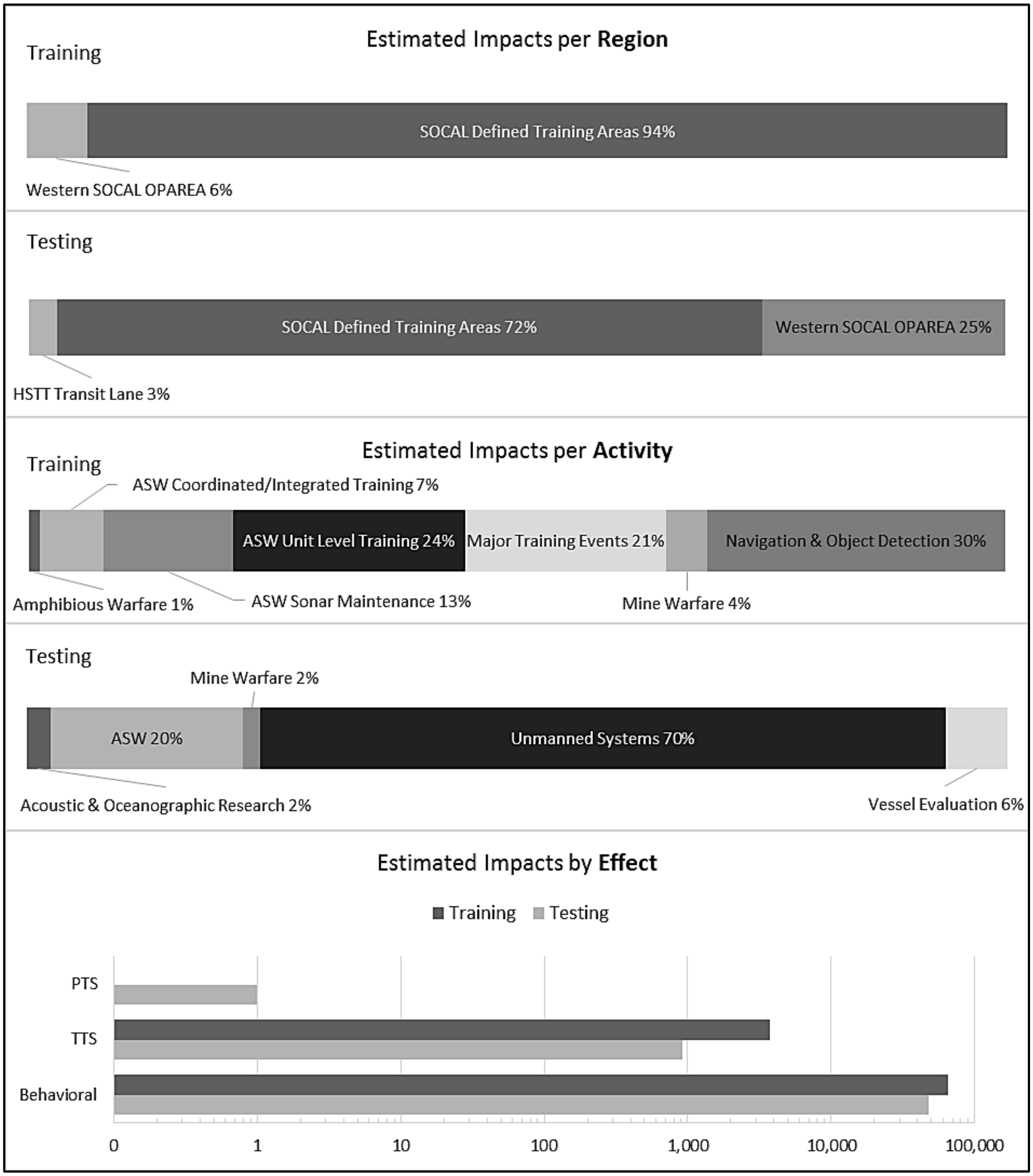


Figure 3.7-87: California Sea Lion Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent U.S. Stock. ASW = Anti-Submarine Warfare

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. See Figure 3.7-88 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the U.S. stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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, TTS, and PTS under Alternative 2. See Figure 3.7-88 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the U.S. stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 California sea lions incidental to those activities.

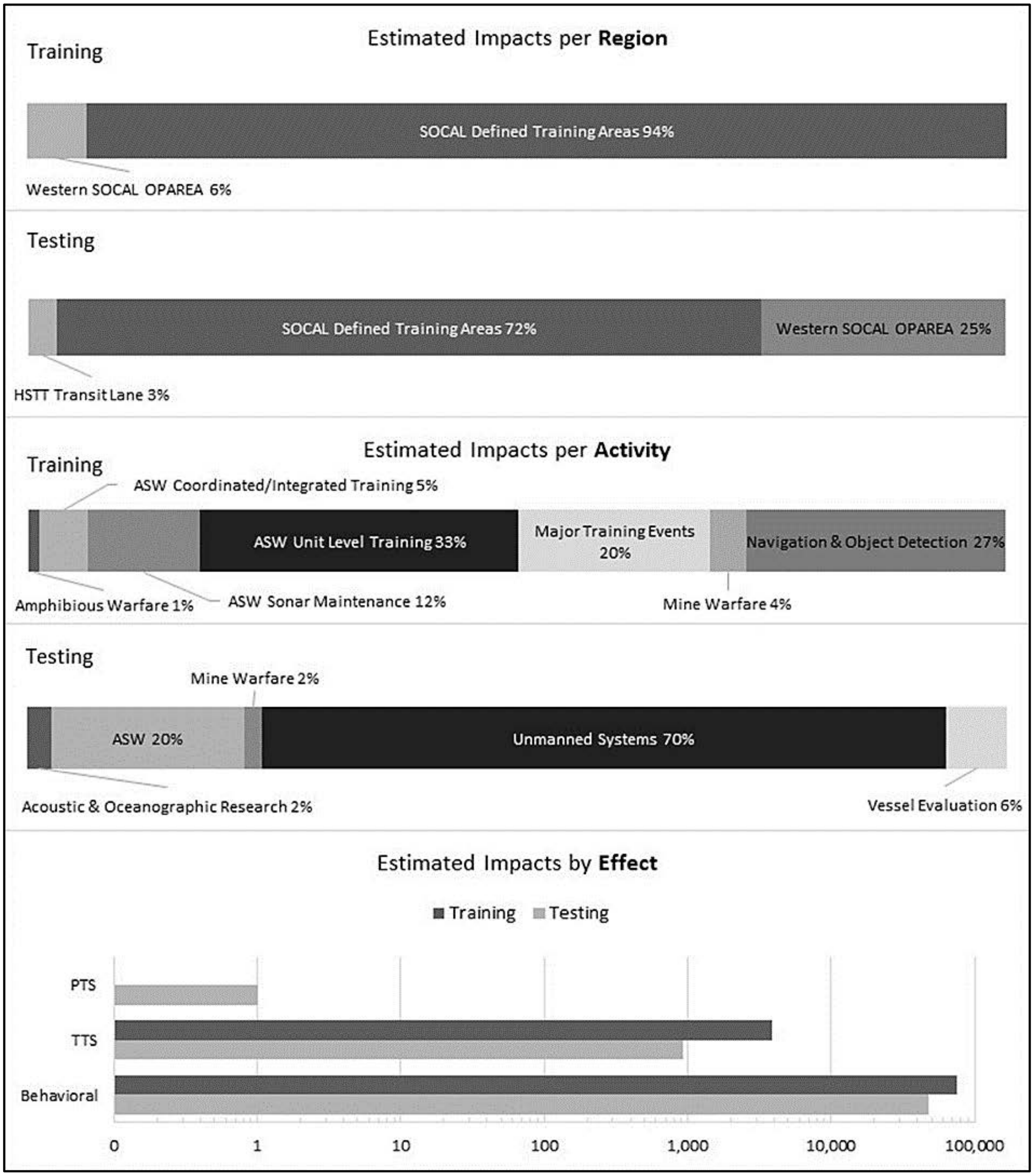


Figure 3.7-88: California Sea Lion Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100 percent U.S. Stock. ASW = Anti-Submarine Warfare

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. See Figure 3.7-89 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

As described for other 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 will 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 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. See Figure 3.7-89 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

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 will 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 fur seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

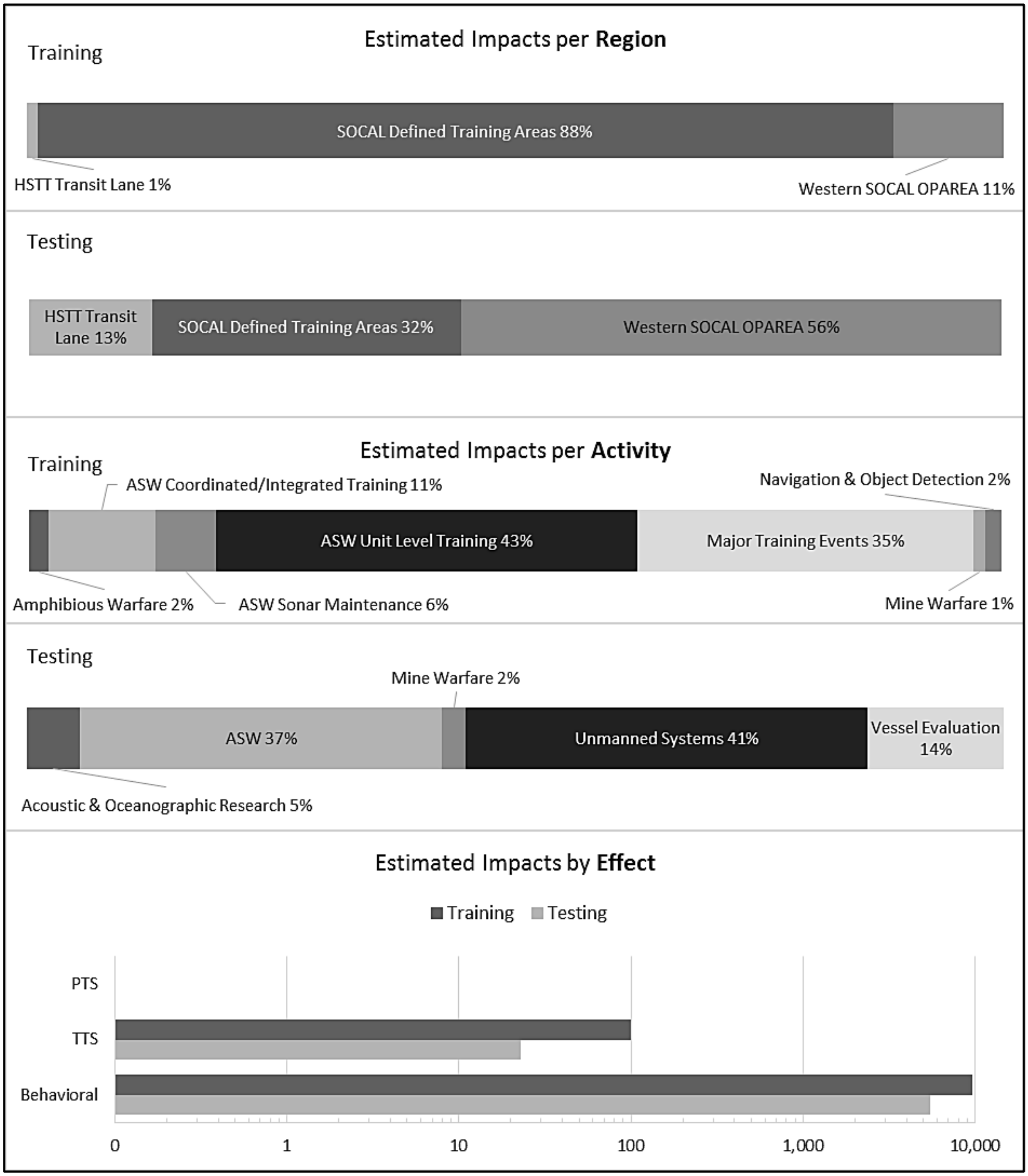


Figure 3.7-89: Northern Fur Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California Stock. ASW = Anti-Submarine Warfare

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. See Figure 3.7-90 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers of 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. See Figure 3.7-90 below or Appendix E for tabular results. Impact ranges for this species are discussed in Section 3.7.3.1.2.2 (Impact Ranges from Sonar and Other Transducers). Estimated impacts apply only to the California stock.

Potential impacts under Alternative 2 from sonar and other transducers would be similar in type as for Alternative 1, although the numbers 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 Northern fur seals incidental to those activities.

Figure 3.7-90: Northern Fur Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under Alternative 2

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100 percent California Stock. ASW = Anti-Submarine Warfare

3.7.3.1.2.4 Impacts from Sonar and Other Transducers Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Based on the analysis presented in Sections 3.7.3.1.2.3 (Impacts from Sonar and Other Transducers Under the Action Alternatives), impacts on individual marine mammals from activities that use sonar and other transducers could occur under either alternative, but impacts on marine mammal populations are not anticipated. Therefore, discontinuing activities that use sonar and other transducers under the No Action Alternative would remove the potential for impacts on individual marine mammals, but would not measurably improve the status of marine mammal populations or otherwise contribute to the recovery of threatened or endangered species that occur in the Study Area.

3.7.3.1.3 Impacts from Air Guns

Air guns use bursts of pressurized air to create broadband, impulsive sounds. Any use of air guns would typically be transient and temporary. Section 3.0.3.3.1.2 (Air Guns) provides additional details on the use and acoustic characteristics of the small air guns used in these activities. The use of air guns will not affect Hawaiian monk seal critical habitat and will not be analyzed further in this section.

3.7.3.1.3.1 Methods for Analyzing Impacts from Air Guns

The Navy performed a quantitative analysis to estimate the number times that marine mammals could be affected by air guns used during Navy 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 animals may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. The steps of this quantitative analysis are described in Section 3.0.1.2 (Marine Species Density Database), which takes into account:

- criteria and thresholds used to predict impacts from air guns (see below)
- the density and spatial distribution of marine mammals
- the influence of environmental parameters (e.g., temperature, depth, salinity) on sound propagation when estimating the received sound level on the animals

A further 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*.

Criteria and Thresholds used to Predict Impacts on Marine Mammals from Air Guns

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.

Auditory Weighting Functions

Weighting functions are specific to each hearing group, but are the same across all noise types (e.g., sonar, air guns, and pile driving). See Auditory Weighting Functions under Section 3.7.3.1.2.1, Methods for Analyzing Impacts from Sonars and Other Transducers, for information on the weighting thresholds used for analyzing sound from air guns.

Hearing Loss from Air Guns

Criteria used to define threshold shifts from impulsive sound sources were 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 7–20 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 onset TTS SEL threshold for impulsive sources and 6 dB to the onset TTS peak SPL thresholds. This relationship was derived by Southall et al. (2007). These frequency dependent thresholds are depicted by the exposure functions for each group's range of best hearing (see Table 3.7-51 and Figure 3.7-91).

Table 3.7-51: Thresholds for Onset of TTS and PTS for Underwater Air Gun Sounds

Hearing group	Onset TTS		Onset PTS	
	SEL dB re 1 μPa²s (weighted)	***SPL peak dB re 1 μPa*** (unweighted)	***SEL dB re 1 μPa²s*** (weighted)	***SPL peak dB re 1 μPa*** (unweighted)
Low-frequency Cetaceans	168	213	183	219
Mid-frequency Cetaceans	170	224	185	230
High-frequency Cetaceans	140	196	155	202
Otariids in water	188	226	203	232
Phocid seals in water	170	212	185	218

Notes: PTS= permanent threshold shift, SEL= sound exposure level, SPL= sound pressure level, TTS= temporary threshold shift

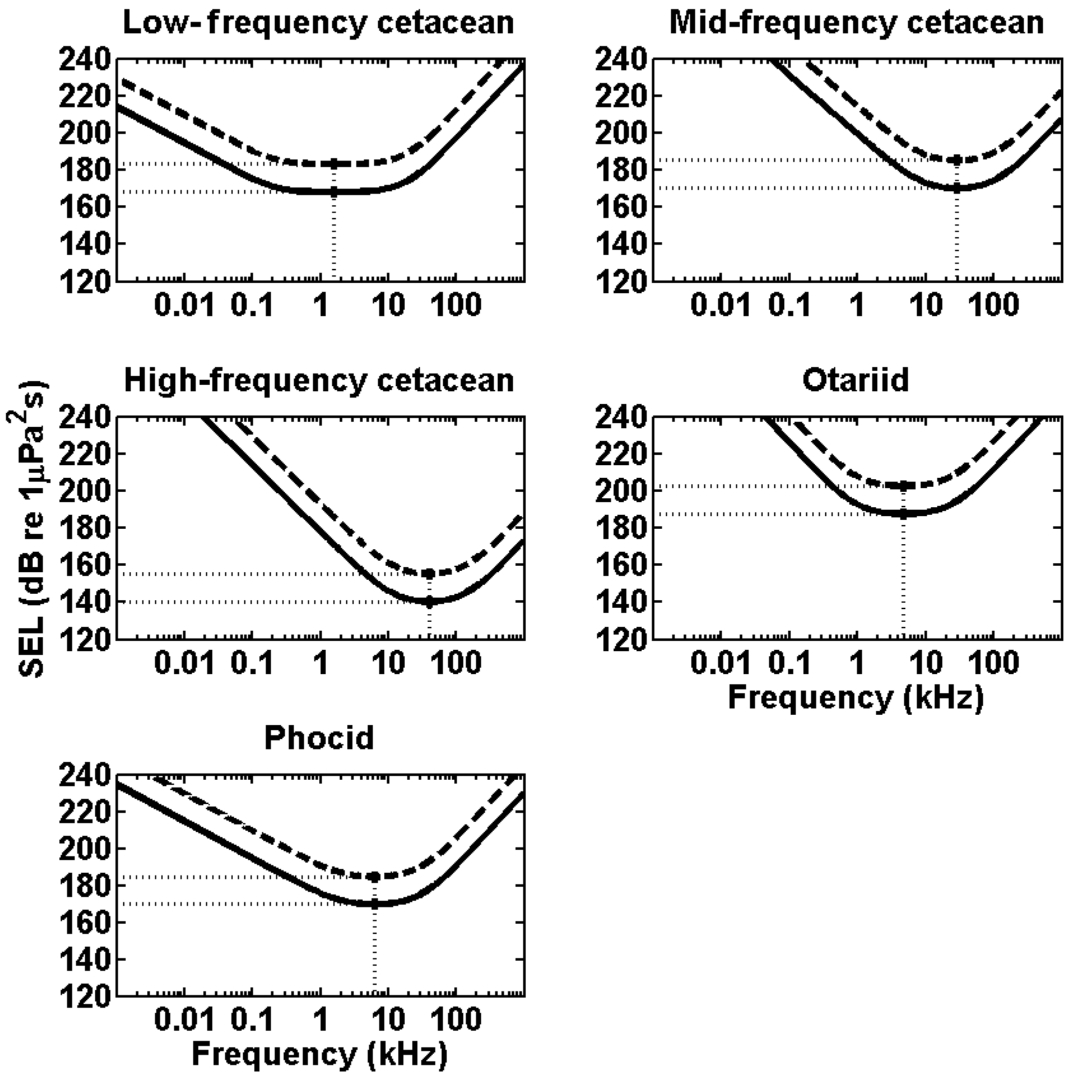


Figure 3.7-91: Temporary Threshold Shift and Permanent Threshold Shift Exposure Functions for Air Guns

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.

Behavioral Responses from Air Guns

The existing NMFS Level B disturbance threshold of 160 dB re 1 µPa (rms) is applied to the unique sounds generated by air guns. The root mean square calculation for air guns is based on the duration defined by 90 percent of the cumulative energy in the impulse.

3.7.3.1.3.2 Impact Ranges for Air Guns

Table 3.7-52 and Table 3.7-53 present the approximate ranges in meters to PTS, TTS, and potential behavioral reactions for air guns for 1 and 10 pulses, respectively. Ranges are specific to the HSTT Study area and also specific to each marine mammal hearing group, dependent upon their criteria and the specific locations where animals from the hearing groups and the air gun activities could overlap.

Table 3.7-52: Range to Effects from Air Guns for 1 Pulse

Range to Effects for Air guns[1] for 1 pulse (m)					
Hearing Group	***PTS (SEL)***	***PTS (Peak SPL)***	***TTS (SEL)***	***TTS (Peak SPL)***	***Behavioral[2]***
High-Frequency Cetacean	0 (0–0)	18 (15–25)	1 (0–2)	33 (25–80)	702 (290–1,525)
Low-Frequency Cetacean	3 (3–4)	2 (2–3)	27 (23–35)	5 (4–7)	651 (200–1,525)
Mid-Frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	689 (290–1,525)
Otariids	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	590 (290–1,525)
Phocids	0 (0–0)	2 (2–3)	0 (0–0)	5 (4–8)	668 (290–1,525)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses.
[2]Behavioral values depict the ranges produced by RMS hearing threshold criteria levels.

Table 3.7-53: Range to Effects from Air Guns for 10 Pulses

Range to Effects for Air guns[1] for 10 pulses (m)					
Hearing Group	***PTS (SEL)***	***PTS (Peak SPL)***	***TTS (SEL)***	***TTS (Peak SPL)***	***Behavioral[2]***
High-Frequency Cetacean	0 (0–0)	18 (15–25)	3 (0–9)	33 (25–80)	702 (290–1,525)
Low-Frequency Cetacean	15 (12–20)	2 (2–3)	86 (70–140)	5 (4–7)	651 (200–1,525)
Mid-Frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	689 (290–1,525)
Otariids	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	590 (290–1,525)
Phocids	0 (0–0)	2 (2–3)	4 (3–5)	5 (4–8)	668 (290–1,525)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses.
[2]Behavioral values depict the ranges produced by RMS hearing threshold criteria levels.

3.7.3.1.3.3 Impacts from Air Guns under Alternative 1

Impacts from Air Guns Under Alternative 1 for Training Activities

Training activities do not include the use of air guns.

Impacts from Air Guns Under Alternative 1 for Testing Activities

Characteristics of air guns and the number of times they would be operated during testing under Alternative 1 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities using air guns would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Under Alternative 1, small air guns (12–60 in.^{3}) would be fired at off-shore locations in both the Southern California and Hawaii Range Complexes.

Single, small air guns lack the peak pressures that could cause non-auditory injury [see Finneran et al. (2015); also Section 3.7.3.2.1.1 (Injury) in Explosive Stressors]. Potential impacts could include PTS, TTS, behavioral reactions, physiological stress and masking (see Figure 3.7-92 and Appendix E for tabular results).

Research and observations (see Section 3.7.3.1.1.5, Behavioral Reactions) show that if marine mammals are exposed to sounds from air guns they could potentially react with short-term behavioral reactions and physiological stress. It is important to point out that many observations of marine mammal reactions to air guns are from oil and gas exploration activities that use large air gun arrays and operate continuously for multiple weeks to cover large areas of the ocean. Navy activities, in contrast, only use single air guns over a much shorter period over a limited area. Reactions to single air guns, which are used in a limited fashion, are less likely to occur or rise to the same level of severity. Cetaceans (both mysticetes and odontocetes) may react in a variety of ways to impulsive sounds, which may include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, changing vocalization, or showing no response at all. Research shows that pinnipeds may be the least sensitive taxonomic group to most noise sources, and are likely to respond to loud impulsive sound sources only at close ranges by startling or ceasing foraging, but only for brief periods before returning to their previous behavior. Pinnipeds may even experience mild TTS before exhibiting a behavioral response (Southall et al., 2007). Marine mammals disturbed while engaged in 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 air gun activities is short-term and intermittent, it is unlikely that a marine mammal would be exposed to noise that would result in any more than a short-term and mild to moderate behavioral responses.

The sound from air gun shots is broadband, but they have a very short duration, lasting for less than a second each, and are used intermittently. This limits the potential for any significant masking in marine mammals. The effects of masking are only present when the sound source is actively producing sound and the effect is over the moment the sound has ceased. Given these factors, significant masking is unlikely to occur in marine mammals due to exposure to sound from air guns.

As discussed above, estimated impacts on marine mammals from air gun sounds associated with testing activities are likely to consist of a small number of behavioral responses, TTS and PTS. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS (a few dB or less) in an individual could have no to minor long-term consequences for individuals. Because these activities only occur a few times per year, have a small footprint of potential impacts with no impacts estimated for most species, and mitigation measures will be implemented as discussed in

Section 5.3.2.2 (Air Guns), long-term consequences for any marine mammal species or stocks would be unlikely.

The reproduction area for humpback whales identified by Baird et al. (2015a) overlaps the Hawaii Range Complex within the HSTT Study Area. No impacts on humpback whales from exposure to air gun sounds are estimated by the quantitative analysis. This identified humpback whale reproduction area is mostly in shallow, near-shore waters where the Navy does not typically conduct testing activities. Impacts, if they did occur, would most likely be short-term, minor behavioral responses. Therefore, significant impacts on humpback whale reproductive behaviors from air gun sounds associated with testing activities are unlikely to occur within the reproduction area identified by Baird et al. (2015a).

Twenty areas for small and resident populations of various species of odontocetes identified by Baird et al. (2015) are located within the Hawaii Range Complex year-round. These identified areas cover 11 species of odontocetes: dwarf sperm whales (1 area), Blainville's beaked whales (1 area), Cuvier's beaked whales (1 area), pygmy killer whales (1 area), short-finned pilot whales (1 area), melon-headed whales (1 area), false killer whales (1 area), pantropical spotted dolphins (3 areas), spinner dolphins (5 areas), rough-toothed dolphins (1 area), and common bottlenose dolphins (4 areas). The quantitative analysis did estimate a single TTS for dwarf sperm whales, although as discussed above, this is unlikely to occur. Behavioral reactions, if they did occur, would most likely be short-term, minor behavioral responses. Significant impacts on natural behaviors or abandonment of any of the 20 small and resident population areas identified by Baird et al. (2015a) for 11 species of odontocetes would not be anticipated due to exposure to air gun sounds associated with testing activities.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area. However, these feeding areas make up a very small portion of the Study Area. The quantitative analysis estimates a single blue whale may behaviorally respond to an air gun exposure. It is unlikely that air gun noise would affect the feeding behaviors of blue whales on their identified feeding areas beyond short-term, minor behavioral responses. Therefore, significant impacts on blue whale feeding behaviors from air gun sounds associated with testing activities are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Range Complex within the Study Area. The identified areas are active altogether during the months of October through July, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Navy testing activities with air guns could occur year round within the Study Area. The quantitative analysis estimates a single gray whale may behaviorally respond to an air gun exposure. Behavioral responses, if they did occur, would most likely be sort-term and minor. Therefore, significant impacts on gray whale migration behaviors from air gun sounds associated with testing activities are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015).

Pursuant to the MMPA, the use of air guns during testing activities as described under Alternative 1 will result in the unintentional taking of blue whales, gray whales, dwarf and pygmy sperm whales (Kogia whales), bottlenose dolphins, long-beaked common dolphins, northern right whale dolphins, Pacific white-sided dolphins, Risso's dolphins, short-beaked common dolphins, Dall's porpoise, harbor seals, northern elephant seals, California sea lions, and 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.

Pursuant to the ESA, the use of air guns during testing activities as described under Alternative 1 may affect ESA-listed blue whales, but would not affect other ESA-listed marine mammals or main Hawaiian Islands Insular false killer whale critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

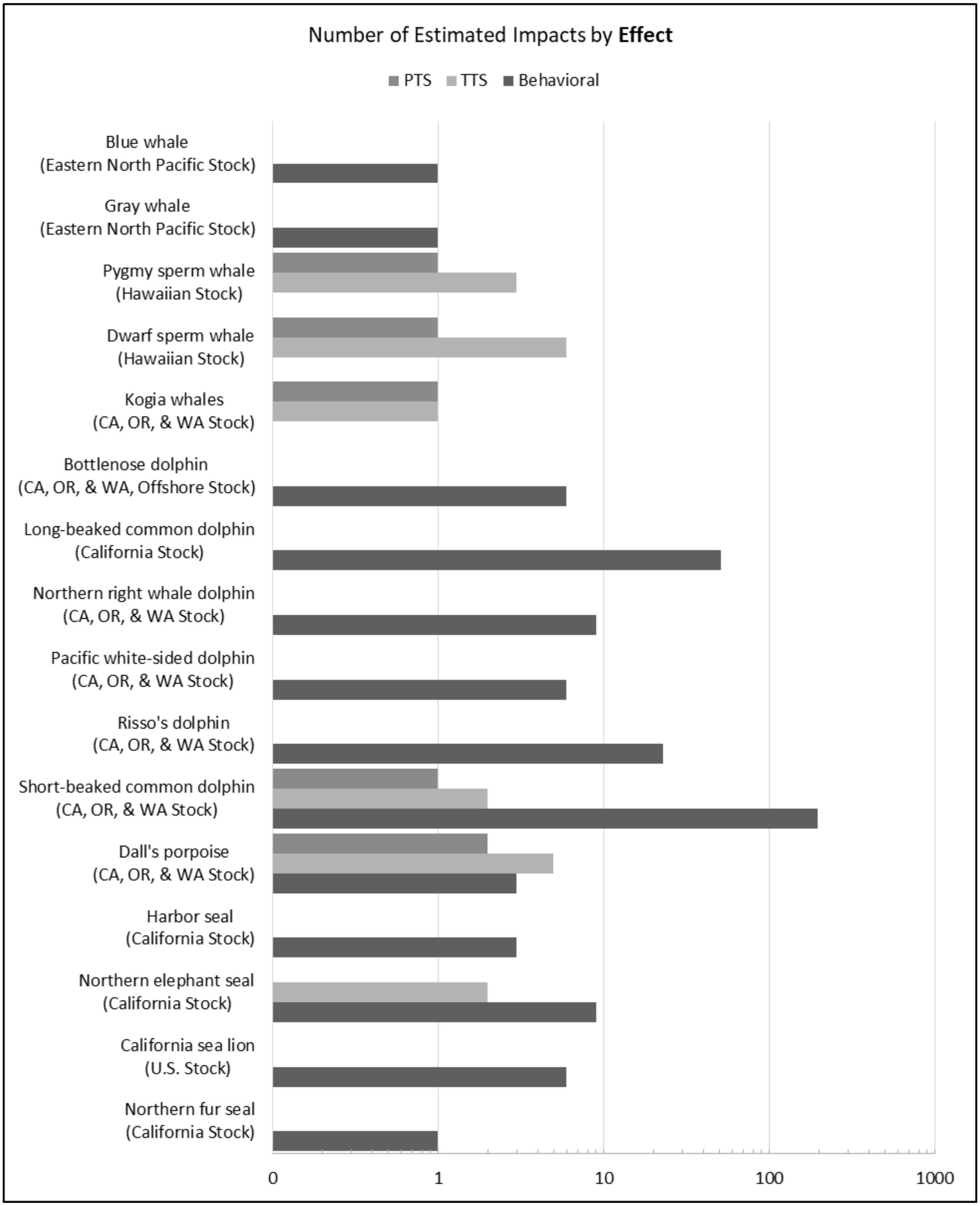


Figure 3.7-92: Estimated Annual Impacts from Air Gun Use

3.7.3.1.3.4 Impacts from Air Guns under Alternative 2

Impacts from Air Guns Under Alternative 2 for Training Activities

Training activities do not include the use of air guns.

Impacts from Air Guns Under Alternative 2 for Testing Activities

Air gun activities planned under Alternative 2 are identical to those planned under Alternative 1; therefore, the estimated impacts would be identical (see Figure 3.7-92 and Appendix E for tabular results).

Pursuant to the MMPA, the use of air guns during testing activities as described under Alternative 2 will result in the unintentional taking of blue whales, gray whales, dwarf and pygmy sperm whales, Kogia whales, bottlenose dolphins, long-beaked common dolphins, northern right whale dolphins, Pacific white-sided dolphins, Risso's dolphins, short-beaked common dolphins, Dall's porpoise, harbor seals, northern elephant seals, California sea lions, and northern fur seals incidental to those activities.

Pursuant to the ESA, the use of air guns during testing activities as described under Alternative 2 may affect ESA-listed blue whales, but would not affect other ESA-listed marine mammals or main Hawaiian Islands Insular false killer whale critical habitat.

3.7.3.1.3.5 Impacts from Air Guns Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Based on the analysis presented in Sections 3.7.3.1.3.3 (Impacts from Air Guns Under Alternative 1) and 3.7.3.1.3.4 (Impacts from Air Guns Under Alternative 2), impacts on individual marine mammals from air gun activities could occur under either action alternative, but impacts on marine mammal populations are not anticipated. Therefore, discontinuing air gun activities under the No Action Alternative would remove the potential for impacts on individual marine mammals, but would not measurably improve the status of marine mammal populations or otherwise contribute to the recovery of threatened or endangered species that occur in the Study Area.

3.7.3.1.4 Impacts from Pile Driving

Marine mammals could be exposed to sounds from impact and vibratory pile driving during the construction and removal phases of the Elevated Causeway System described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.3-2. The training involves the use of an impact hammer to drive the 24-inch (in.) steel piles into the sediment followed by a vibratory hammer to remove the piles that support the causeway structure. Impact pile driving operations to install the piles averages about 20 days, and removal of the piles at the end of the exercise takes approximately 10 days. Section 3.0.3.3.1.3 (Pile Driving) provides additional details on pile driving and noise levels measured from similar operations. The use of pile driving and removal will not affect Hawaiian monk seal or main Hawaiian Islands insular false killer whale critical habitats and they will not be analyzed further in this section.

3.7.3.1.4.1 Methods for Analyzing Impacts from Pile Driving

The Navy performed a quantitative analysis to estimate the number of marine mammals that could be impacted by pile driving used during Navy training activities. The Navy's quantitative analysis to determine impacts on marine mammals from pile driving produces initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. The steps of this quantitative analysis are described in Section 3.0.1.2 (Marine Species Density Database), which takes into account:

- criteria and thresholds used to predict impacts from pile driving (see below)
- the density and spatial distribution of marine mammals
- the influence of environmental parameters (e.g., temperature, depth, salinity) on sound propagation when estimating the received sound level on the animals

A further 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*.

Criteria and Thresholds Used to Estimate Impacts on Marine Mammals from Pile Driving

See the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* technical report (U.S. Department of the Navy, 2017a) for detailed information on how the criteria and thresholds were derived.

Auditory Weighting Functions

Weighting functions are specific to each hearing group, but are the same across all noise types (e.g., sonar, air guns, and pile driving). See Auditory Weighting Functions under Section 3.7.3.1.2.1, Methods for Analyzing Impacts from Sonars and Other Transducers, for information on the weighting functions used for analyzing sound from pile driving.

Hearing Loss from Pile Driving

Because vibratory pile removal produces continuous, non-impulsive noise, the criteria used to assess the onset of TTS and PTS due to exposure to sonars are used to assess auditory impacts on marine mammals (see Hearing Loss from Sonar and Other Transducers in Section 3.7.3.1.2.1, Methods for Analyzing Impacts from Sonars and Other Transducers).

Because impact pile driving produces impulsive noise, the criteria used to assess the onset of TTS and PTS are identical to those used for air guns (see Hearing Loss from Air Guns in Section 3.7.3.1.3.1, Methods for Analyzing Impacts from Air Guns).

Behavioral Responses from Pile Driving

Existing NMFS risk criteria are applied to estimate behavioral effects from impact and vibratory pile driving (Table 3.7-54).

Table 3.7-54: Pile Driving Level B Thresholds Used in this Analysis to Predict Behavioral Responses from Marine Mammals

Pile Driving Level B Disturbance Threshold (Sound Pressure Level, dB re 1 µPa)	
Underwater Vibratory	***Underwater Impact***
120 dB rms	160 dB rms

Note: Root mean square calculation for impact pile driving is based on the duration defined by 90 percent of the cumulative energy in the impulse. Root mean square for vibratory pile driving is calculated based on a representative time series long enough to capture the variation in levels, usually on the order of a few seconds.
dB = decibel, dB re 1 µPa = decibel referenced to 1 micro pascal, rms = root mean square

Modeling of Pile Driving Noise

Underwater noise effects from pile driving and vibratory pile extraction were modeled using actual measures of impact pile driving and vibratory removal during construction of an elevated causeway (Illingworth and Rodkin, 2015, 2017). A conservative estimate of spreading loss of sound in shallow coastal waters (i.e., transmission loss = 16.5*Log10[radius]) was applied based on spreading loss observed in actual measurements. Inputs used in the model are provided in Section 3.0.3.3.1.3 (Pile Driving), including source levels; the number of strikes required to drive a pile and the duration of vibratory removal per pile; the number of piles driven or removed per day; and the number of days of pile driving and removal.

The exposures predicted from elevated causeway assessment rely on the assumption that marine mammals are uniformly distributed within the ocean waters adjacent the proposed event locations. In fact, animal presence in the surf zone and nearshore waters of the Silver Strand Training Complex and Marine Corps Base Camp Pendleton (within a few kilometers) is known to be patchy and infrequent with the exception of a few coastal species (e.g., common dolphins, bottlenose dolphins, harbor seals, and sea lions; sea otters should not be present where proposed pile driving may occur).

3.7.3.1.4.2 Impact Ranges for Pile Driving

Table 3.7-55 and Table 3.7-56 present the approximate ranges in meters to PTS, TTS, and potential behavioral reactions for impact pile driving and vibratory pile removal, respectively.

Table 3.7-55: Average Ranges to Effects from Impact Pile Driving Based on a Single Pile

Hearing Group	*PTS (m)*	*TTS (m)*	*Behavioral (m)*
Low-frequency Cetaceans	65	529	870
Mid-frequency Cetaceans	2	16	870
High-frequency Cetaceans	65	529	870
Phocids	19	151	870
Otariids	2	12	870

Notes: PTS=permanent threshold shift; TTS=temporary threshold shift

Table 3.7-56: Average Ranges to Effect from Vibratory Pile Extraction Based on a Single Pile

Hearing Group	*PTS (m)*	*TTS (m)*	*Behavioral (m)*
Low-frequency Cetaceans	0	3	376
Mid-frequency Cetaceans	0	4	376
High-frequency Cetaceans	7	116	376
Phocids	0	2	376
Otariids	0	0	376

Notes: PTS= permanent threshold shift; TTS= temporary threshold shift

3.7.3.1.4.3 Impacts from Pile Driving under Alternative 1

Impacts from Pile Driving Under Alternative 1 for Training Activities

Characteristics of pile driving and the number of times pile driving for the Elevated Causeway System would occur during training under Alternative 1 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities with pile driving would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). This activity would take place nearshore and within the surf zone, up to two times per year, once at Silver Strand Training Complex and once at Marine Corps Base Camp Pendleton. These coastal areas tend to have high ambient noise levels due to natural and anthropogenic sources and typically have limited numbers of sensitive marine mammal species present.

Sounds from the impact hammer are impulsive, broadband and dominated by lower frequencies. The impulses are within the hearing range of marine mammals. Sounds produced from a vibratory hammer are similar in frequency range as that of the impact hammer, except the levels are much lower than for the impact hammer and the sound is continuous while operating. Potential impacts on marine mammals due to exposure to pile driving sounds include hearing loss, behavioral reactions, physiological stress, and masking, although the quantitative analysis (see Figure 3.7-93 and Appendix E for tabular results) estimates only behavioral reactions in a few species due to exposure to pile driving activities associated with the construction and removal of the elevated causeway.

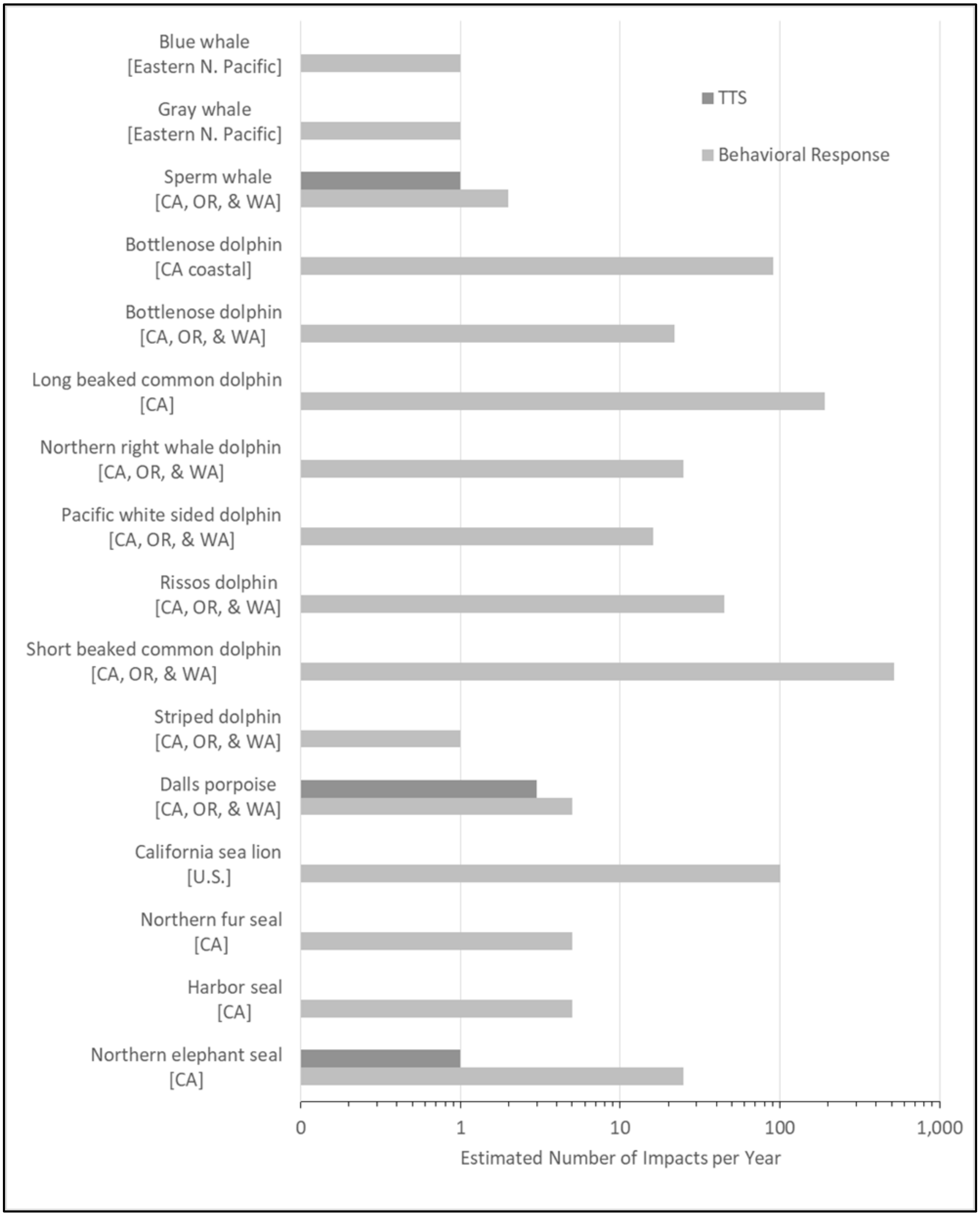


Figure 3.7-93: Estimated Annual Impacts (Assuming Two Events per Year) from Pile Driving and Extraction Associated with the Construction and Removal of the Elevated Causeway System

Note: No impacts are anticipated for any other species within the HSTT Study Area. See Appendix E for tabular. No PTS is estimated for pile driving activities. This activity would not occur within the Hawaii Range Complex.

Behavioral responses due to impact pile driving could occur out to a distance of approximately 1 km. The vibratory hammer produces a much lower source level than the impact hammer, especially when extracting piles from sandy, nearshore ground; therefore, the potential for reactions in marine mammals due to vibratory pile extraction are unlikely. Short-term behavioral reactions to impact pile driving are much more likely.

Research and observations (see Section 3.7.3.1.1.5, Behavioral Reactions) show that if marine mammals are exposed to sounds from pile driving or extraction they could potentially react with short-term behavioral reactions and physiological stress. Mysticetes 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 source is located directly on their migration route, although training associated with the elevated causeway is conducted nearshore, outside of any migratory paths for mysticetes. Odontocete reactions could include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, change in vocalization, or showing no response at all. Research shows that pinnipeds may be the least sensitive taxonomic group to most noise sources, and are likely to respond to loud impulsive sound sources only at close ranges by startling or ceasing foraging, but only for brief periods before returning to their previous behavior. Pinnipeds may even experience mild TTS before exhibiting a behavioral response (Southall et al., 2007). Marine mammals disturbed while engaged in 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 pile driving activities is short-term, intermittent, and occurs within a nearshore environment with high levels of ambient noise, it is unlikely that a marine mammal would be exposed to noise that would result in any more than a short-term and mild to moderate behavioral responses. The Navy will implement mitigation measures to avoid or reduce potential impacts from pile driving on marine mammals, as discussed in Section 5.3.2.3 (Pile Driving).

The vibratory hammer produces sounds that are broadband and continuous, creating the potential to cause some masking in marine mammals, but the effect would be temporary because extracting a pile only takes about six minutes, with a pause between each pile. Due to the low source level of vibratory pile extraction, the zone for potential masking would only extend a few hundred meters from where the hammer is operating. For impact pile driving, the average rate of 35 strikes per minute has the potential to result in some masking in marine mammals. The effect would be temporary as each pile only takes about 15 minutes to drive, with a pause of up to an hour before the next pile is driven. Furthermore, the Elevated Causeway System is constructed in shallow, nearshore areas where ambient noise levels are already typically high. The effects of masking are only present when the sound source is actively producing sound and the effect is over the moment the sound has ceased. Given these factors, significant masking is unlikely to occur in marine mammals due to exposure to sound from impact pile driving or vibratory pile extraction.

As discussed above, estimated impacts on marine mammals from pile driving and extraction associated with the construction and removal of the elevated causeway consist of primarily short-term behavioral reactions, and potentially a few minor to moderate TTS (6–20 dB measured directly after exposure). Because these activities only occur a few weeks per year and have a small footprint of potential impacts, the same animal would not be expected to be impacted more than a few times in a given year due to exposure pile driving sound. A single TTS or behavioral reaction in an individual animal within a given year is very unlikely to have any long-term consequences for that individual. Considering these factors, and the low number of overall estimated impacts, long-term consequences for marine mammal species or stocks would be unlikely.

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Range Complex within the Study Area. The identified areas are active altogether during the months of October through July, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Construction and removal of the elevated causeway could occur up to two times per year during any time of year at Silver Strand Training Complex or MCB Camp Pendleton in the nearshore environment, which is within a designated gray whale migration area. As discussed above, gray whales may pause their migration or re-route if a sound source is located directly on their path, however pile driving and extraction is performed within the surf zone and in the nearshore environment, outside of the migratory corridor. Gray whale reactions, if they did occur would most likely to be short-term and mild. Therefore, significant impacts on gray whale migration behaviors from are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015) because of pile driving and extraction associated with the construction and removal of the Elevated Causeway System.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Portion of the HSTT Study Area in July through October. Construction and removal of the elevated causeway could occur up to two times per year during any time of year at Silver Strand Training Complex or MCB Camp Pendleton in the nearshore environment, which is near a designated blue whale feeding area. Blue whales within this designated area could be exposed to distant sounds from pile driving and extraction training activities. As discussed above, mysticete reactions to impulsive sound would most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away and when the animals are engaged in important biological behaviors such as feeding. Therefore, significant impacts on blue whale feeding behaviors are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015) because of pile driving and extraction associated with the construction and removal of the elevated causeway.

Pursuant to the MMPA, pile driving and removal during training activities as described under Alternative 1 will result in the unintentional taking of blue whales, gray whales, sperm whales, bottlenose dolphins, long-beaked common dolphins, northern right whale dolphins, Pacific white-sided dolphins, Risso's dolphins, short-beaked common dolphins, striped dolphins, Dall's porpoises, harbor seals, northern elephant seals, California sea lions and 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.

Pursuant to the ESA, pile driving and removal during training activities as described under Alternative 1 may affect ESA-listed blue whales and sperm whales, but would not affect other ESA-listed marine mammals or main Hawaiian Islands Insular false killer whale critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Pile Driving Under Alternative 1 for Testing Activities

Testing activities do not include pile driving.

3.7.3.1.4.4 Impacts from Pile Driving under Alternative 2

Impacts from Pile Driving Under Alternative 2 for Training Activities

Pile driving activities planned under Alternative 2 are identical to those planned under Alternative 1; therefore, the estimated impacts would be identical (see Figure 3.7-93 and Appendix E for tabular results).

Pursuant to the MMPA, pile driving and removal during training activities as described under Alternative 2 will result in the unintentional taking of blue whales, gray whales, sperm whales, bottlenose dolphins, long-beaked common dolphins, northern right whale dolphins, Pacific white-sided dolphins, Risso's dolphins, short-beaked common dolphins, striped dolphins, Dall's porpoises, harbor seals, northern elephant seals, California sea lions, and northern fur seals incidental to those activities.

Pursuant to the ESA, pile driving and removal during training activities as described under Alternative 2 may affect ESA-listed blue whales and sperm whales, but would not affect other ESA-listed marine mammals or main Hawaiian Islands Insular false killer whale critical habitat.

Impacts from Pile Driving Under Alternative 2 for Testing Activities

Testing activities do not include pile driving.

3.7.3.1.4.5 Impacts from Pile Driving Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Based on the analysis presented in Sections 3.7.3.1.4.3 (Impacts from Pile Driving Under Alternative 1) and 3.7.3.1.4.4 (Impacts from Pile Driving Under Alternative 2), impacts on individual marine mammals from pile driving activities could occur under either action alternative, but impacts on marine mammal populations are not anticipated. Therefore, discontinuing pile driving activities under the No Action Alternative would remove the potential for impacts on individual marine mammals, but would not measurably improve the status of marine mammal populations or otherwise contribute to the recovery of threatened or endangered species that occur in the Study Area.

3.7.3.1.5 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 3.0.3.3.1.4 (Vessel Noise). Vessel movements involve transits to and from ports to various locations within the Study Area. At San Diego Bay for example, there are about 225 commercial ship transits per day, most during daylight hours, plus an unknown but potentially equal number of recreational vessels moving in and out of the bay (U.S. Department of the Navy, 2013a, 2015b). The Port of San Diego reports in 2015 a total of 594 voyages by deep draft commercial cargo vessels and cruise ships, representing 1,350 transits in and out of San Diego Bay annually, with recreational boaters for the area numbered at 200,000 (Port of San Diego, 2015). In this context, many ongoing and proposed Navy training and testing activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels).

Noise from vessels generally lacks the amplitude and duration to cause any hearing loss in marine mammals under realistic conditions. Noise from vessels is generally low frequency (10 to hundreds Hz), although at close range or in shallow water it can extend above 100 kHz at received levels above 100 dB re 1 µPa (Hermannsen et al., 2014). Although periods of broadband noise tend to be brief, occurring only as a vessel is passing within a few hundred meters, vessel noise could lead to short-term masking for all marine mammal species (Section 3.7.3.1.1.4, Masking). Vessel noise has been linked to behavioral responses (Section 3.7.3.1.1.5, Behavioral Reactions), although it is difficult to separate responses to the noise from reactions to the physical presence of the vessel. Physiological stress has also been linked to chronic vessel noise, such as that in shipping lanes or heavily trafficked whale-watch areas (Section 3.7.3.1.1.3, Physiological Stress). However, based on the generally short duration, relatively low source levels of many Navy vessels, and the transient nature of Navy vessel noise, behavioral, physiological stress and masking reactions, if they occur, are unlikely to be significant.

3.7.3.1.5.1 Methods for Analyzing Impacts from Vessel Noise

Responses to vessel noise have been observed for marine mammals when the noise is chronic and persistent such as near constricted ocean shipping lanes, and while Navy vessels do transit over regular areas, the number of ships is several magnitudes smaller than found in shipping lanes. Navy vessels also maneuver to avoid marine mammals when possible; therefore, significant responses to passing vessels are unlikely. The amount of radiated sound from Navy vessels is based on measured levels (see Section 3.0.3.3.1.4, Vessel Noise). These sound levels, along with operational characteristics of the vessel (e.g., source level due to cavitation, speed), are compared to situations where researchers have observed behavioral reactions (see Behavioral Responses to Vessel Noise under Section 3.7.3.1.1.5, Behavioral Reactions) or masking (see 3.7.3.1.1.4, Masking) in marine mammals. The likelihood of behavioral and physiological stress reactions or masking due to Navy vessel noise is then discussed in light of this research.

3.7.3.1.5.2 Impacts from Vessel Noise Under Alternative 1

Impacts from Vessel Noise Under Alternative 1 for Training Activities

Characteristics of Navy vessel noise are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities with vessel noise would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Vessel movements involve transits to and from ports to various locations within the Study Area, and many ongoing and proposed activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels), as well as unmanned vehicles. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to two weeks. Navy vessel traffic could occur anywhere within the Study Area, but would be concentrated within the easternmost part of Southern California and around the major Hawaiian Islands, particularly the area surrounding Honolulu (Mintz, 2012). Training activities that could generate vessel noise could occur throughout the Study Area but would occur primarily in the Southern California and Hawaii Range Complexes.

Activities involving vessel movements are variable in duration, ranging from a few hours up to two weeks, but are typically episodic and related to training. During training, speeds generally range from 10 to 14 knots; however, vessels can and will, on occasion, operate within the entire spectrum of their specific operational capabilities. In addition, a variety of smaller craft will be operated within the Study Area. Small craft types, sizes, and speeds vary. In all cases, the vessels/craft will be operated in a safe manner consistent with the local conditions. Section 3.7.3.1.1.5 (Behavioral Reactions) discusses scientific studies and observations of marine mammal reactions, while potential masking from vessel presence and noise is discussed in Section 3.7.3.1.1.4 (Masking).

Vessel traffic related to the proposed activity would pass near marine mammals only on an incidental basis. Navy ports such as San Diego and Pearl Harbor are heavily trafficked with private and commercial vessels in addition to naval vessels. Because Navy ships make up only a small proportion of the total ship traffic, even in the most concentrated port and inshore areas, proposed Navy vessel transits are unlikely to cause significant behavioral responses or long-term abandonment of habitat by a marine mammal. 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 Movements). The mitigation for vessel movements (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.

Vessel noise can potentially mask vocalizations and other biologically important sounds (e.g., sounds of prey or predators) that marine mammals may rely on. Potential masking can vary depending on the ambient noise level within the environment, the received level and frequency of the vessel noise, and the received level and frequency of the sound of biological interest. In the open ocean, ambient noise levels are between about 60 and 80 dB re 1 µPa in the band between 10 Hz and 10 kHz due to a combination of natural (e.g., wind) and anthropogenic sources (Urick, 1983), while inshore noise levels, especially around busy ports, can exceed 120 dB re 1 µPa. When the noise level is above the sound of interest, and in a similar frequency band, masking could occur (Section 3.7.3.1.1.4, Masking). This analysis assumes that any sound that is above ambient noise levels and within an animal's hearing range may potentially cause masking. However, the degree of masking increases with increasing noise levels; a noise that is just detectable over ambient levels is unlikely to cause any substantial masking. Masking by passing ships or other sound sources transiting the Study Area would be short term and intermittent, and therefore unlikely to result in any substantial costs or consequences to individual animals or populations. Areas with increased levels of ambient noise from anthropogenic noise sources such as areas around busy shipping lanes and near harbors and ports may cause sustained levels of masking for marine mammals, which could reduce an animal's ability to find prey, find mates, socialize, avoid predators, or navigate. However, Navy vessels make up a very small percentage of the overall traffic (two orders of magnitude lower than commercial ship traffic in the Study Area), and the rise of ambient noise levels in these areas is a problem related to all ocean users, including commercial and recreational vessels and shoreline development and industrialization.

Surface combatant ships (e.g., guided missile destroyer, guided missile cruiser, and Littoral Combat Ship) and submarines are designed to be very quiet to evade enemy detection and typically travel at speeds of 10 or more knots. Actual acoustic signatures and source levels of combatant ships and submarines are classified; however, they are quieter than most other motorized ships. Still, these surface combatants and submarines are likely to be detectable by marine mammals over open-ocean ambient noise levels at distances of up to a few kilometers, which could cause some masking to marine mammals for a few minutes as the vessel passes by. Other Navy ships and small vessels have higher source levels, similar to equivalently sized commercial ships and private vessels. Ship noise tends to be low frequency and broadband; therefore, it may have the largest potential to mask mysticetes that vocalize and hear at lower frequencies than other marine mammals. Noise from large vessels and outboard motors on small craft can produce source levels of 160 to over 200 dB re 1 µPa at 1 m. Therefore, in the open ocean, noise from noncombatant Navy vessels may be detectable over ambient levels for tens of kilometers, and some masking, especially for mysticetes, is possible. In noisier inshore areas around Navy ports and ranges, vessel noise may be detectable above ambient for only several hundred meters. Some masking to marine mammals is likely from noncombatant Navy vessels, on par with similar commercial and recreational vessels, especially in quieter, open-ocean environments.

Vessel noise has the potential to disturb marine mammals and elicit an alerting, avoidance, or other behavioral reaction. Most studies have reported that marine mammals react to vessel sounds and traffic with short-term interruption of feeding, resting, or social interactions (Magalhães et al., 2002;

Richardson et al., 1995b; Watkins, 1981). Some species respond negatively by retreating or responding to the vessel antagonistically, while other animals seem to ignore vessel noises altogether or are attracted to the vessel (Watkins, 1986). Marine mammals are frequently exposed to vessels due to research, ecotourism, commercial and private vessel traffic, and government activities. It is difficult to differentiate between responses to vessel sound and visual cues associated with the presence of a vessel; thus, it is assumed that both play a role in prompting reactions from animals.

Based on studies of a number of species, mysticetes are not expected to be disturbed by vessels that maintain a reasonable distance from them, which varies with vessel size, geographic location, and tolerance levels of individuals. Odontocetes could have a variety of reactions to passing vessels, including attraction, increased traveling time, decreased feeding behaviors, diving, or avoidance of the vessel, which may vary depending on their prior experience with vessels. Kogia species, harbor porpoises, and beaked whales have been observed avoiding vessels. For pinnipeds, data indicate tolerance of vessel approaches, especially for animals in the water. Navy vessels do not purposefully approach marine mammals and are not expected to elicit significant behavioral responses. Overall, marine mammal reactions to vessel noise associated with training activities are likely to be minor and short term, leading to no significant reactions and no long-term consequences.

The reproduction area for humpback whales identified by Baird et al. (2015a) overlaps the Hawaii Range Complex within the HSTT Study Area. This identified humpback whale reproduction area is mostly in shallow, near-shore waters where the Navy does not typically conduct training activities, especially more intense activities such as major training exercises. The identified humpback whale reproduction area does not overlap areas near Honolulu and Pearl Harbor where most Navy vessel traffic occurs. Therefore, most exposures to Navy vessel noise within this identified reproduction area would be from distant vessels. Small Navy boats are more likely to expose humpback whales to vessel noise within identified areas, although Navy vessels (including small boats) avoid approaching marine mammals within 500 yards, which would make reactions unlikely in a mysticete such as a humpback whale. Impacts, if they did occur, would most likely be short-term masking and minor behavioral responses. Therefore, significant impacts on humpback whale reproductive behaviors from vessel noise associated with training activities are unlikely to occur within the reproduction area identified by Baird et al. (2015a).

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area. However, these feeding areas make up a very small portion of the Study Area. It is unlikely that vessel noise would affect the feeding behaviors of blue whales on their identified feeding areas beyond brief behavioral responses or temporary masking. Furthermore, Navy vessels (including small boats) avoid approaching marine mammals within 500 yards, which would make reactions unlikely in a mysticete such as a blue whale. Impacts, if they did occur, would most likely be short-term masking and minor behavioral responses. Therefore, significant impacts on blue whale feeding behaviors from vessel noise associated with training activities are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Range Complex within the Study Area. The identified areas are active altogether during the months of July through March, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Navy training activities could occur year round within the Study Area. Gray whales may experience brief periods of masking by vessel noise in their migration corridor, or they may alter their migration path slightly if vessels are directly on their route. Behavioral responses, if they did occur, would most likely be minor. Therefore, significant impacts on gray whale migration behaviors from vessel noise associated with training activities are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015).

Twenty areas for small and resident populations of various species of odontocetes identified by Baird et al. (2015a) are located within the Hawaii Range Complex year-round. These identified areas cover 11 species of odontocetes: dwarf sperm whales (1 area), Blainville's beaked whales (1 area), Cuvier's beaked whales (1 area), pygmy killer whales (1 area), short-finned pilot whales (1 area), melon-headed whales (1 area), false killer whales (1 area), pantropical spotted dolphins (3 areas), spinner dolphins (5 areas), rough-toothed dolphins (1 area), and common bottlenose dolphins (4 areas). Most of these identified small and resident population areas are located outside of the areas with significant Navy vessel traffic. However, spinner, bottlenose and pantropical dolphins have resident populations that overlap high vessel use areas off the island of Oahu (Calambokidis et al. 2015) although Navy vessel traffic is an order of magnitude less than commercial vessel traffic in this area (Mintz 2012). Reactions, if they did occur, would most likely be short-term masking and minor behavioral responses. Vessels in close proximity may cause a brief approach or startle response, or may lead to no response at all. Significant impacts on natural behaviors or abandonment of any of the 20 small and resident population areas identified by Baird et al. (2015a) for 11 species of odontocetes would not be anticipated due to exposure to vessel noise associated with training activities.

Pursuant to the MMPA, vessel noise during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, vessel noise during training activities as described under Alternative 1 may affect ESA-listed marine mammals but will not affect main Hawaiian Islands Insular false killer whale critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Vessel Noise Under Alternative 1 for Testing Activities

Characteristics of Navy vessel noise are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities with vessel noise would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Testing activities under Alternative 1 include vessel movement during many events. Because many testing activities would use the same or similar vessels as Navy training events, the general locations and types of effects due to vessel noise described above for training would be similar for many testing activities. In addition, smaller vessels would typically be used on Navy testing ranges.

Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to two weeks, but are typically episodic. In addition, a variety of smaller craft will be operated within the Study Area. Small craft types, sizes, and speeds vary. During testing, speeds generally range from 10 to 14 knots; however, vessels can and will, on occasion, operate within the entire spectrum of their specific operational capabilities. In all cases, the vessels will be operated in a safe manner consistent with the local conditions.

Based on studies on a number of species, mysticetes are not expected to be disturbed by vessels that maintain a reasonable distance from them, which varies with vessel size, geographic location, and tolerance levels of individuals. Odontocetes could have a variety of reactions to passing vessels, including attraction, increased traveling time, decreased feeding behaviors, diving, or avoidance of the vessel, which may vary depending on their prior experience with vessels. Kogia whales, harbor porpoises, and beaked whales have been observed avoiding vessels. For pinnipeds, data indicate tolerance of vessel approaches, especially for animals in the water. Navy vessels do not purposefully approach marine mammals and are not expected to elicit significant behavioral responses. Overall, marine mammal reactions to vessel noise associated with testing activities are likely to be minor and short-term, leading to no significant reactions and no long-term consequences.

Proposed testing activities under Alternative 1 that involve vessel movement differ in number and location from training activities under Alternative 1; however, the types and severity of impacts would not be discernible from those described above in Alternative 1 for Training Activities.

The reproduction area for humpback whales identified by Baird et al. (2015a) overlaps the Hawaii Range Complex within the HSTT Study Area. This identified humpback whale reproduction area is mostly in shallow, near-shore waters where the Navy does not typically conduct testing activities. The identified humpback whale reproduction area does not overlap areas near Honolulu and Pearl Harbor where most Navy vessel traffic occurs. Therefore, most exposures to Navy vessel noise within this identified reproduction area would be from distant vessels. Small Navy boats are more likely to expose humpback whales to vessel noise within identified areas, although Navy vessels (including small boats) avoid approaching marine mammals within 500 yards, which would make reactions unlikely in a mysticete such as a humpback whale. Impacts, if they did occur, would most likely be short-term masking and minor behavioral responses. Therefore, significant impacts on humpback whale reproductive behaviors from vessel noise associated with testing activities are unlikely to occur within the reproduction area identified by Baird et al. (2015a).

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area. However, these feeding areas make up a very small portion of the Study Area. It is unlikely that vessel noise would affect the feeding behaviors of blue whales on their identified feeding areas beyond brief behavioral responses or temporary masking. Furthermore, Navy vessels (including small boats) avoid approaching marine mammals within 500 yards, which would make reactions unlikely in a mysticete such as a blue whale. Impacts, if they did occur, would most likely be short-term masking and minor behavioral responses. Therefore, significant impacts on blue whale feeding behaviors from vessel noise associated with testing activities are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Range Complex within the Study Area. The identified areas are active altogether during the months of July through March, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Navy testing activities could occur year round within the Study Area. Gray whales may experience brief periods of masking by vessel noise in their migration corridor, or they may alter their migration path slightly if vessels are directly on their route. Behavioral responses, if they did occur, would most likely be minor. Therefore, significant impacts on gray whale migration behaviors from vessel noise associated with testing activities are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015).

Twenty year-round areas for small and resident populations of various species of odontocetes identified by Baird et al. (2015a)are located within the Hawaii Range Complex. These identified areas cover 11 species of odontocetes: dwarf sperm whales (1 area), Blainville's beaked whales (1 area), Cuvier's beaked whales (1 area), pygmy killer whales (1 area), short-finned pilot whales (1 area), melon-headed whales (1 area), false killer whales (1 area), pantropical spotted dolphins (3 areas), spinner dolphins (5 areas), rough-toothed dolphins (1 area), and common bottlenose dolphins (4 areas). Most of these identified small and resident population areas are located outside of the areas with significant Navy vessel traffic. However, spinner, bottlenose and pantropical dolphins have resident populations that overlap high vessel use areas off the island of Oahu (Calambokidis et al. 2015) although Navy vessel traffic is an order of magnitude less than commercial vessel traffic in this area (Mintz 2012). Reactions, if they did occur, would most likely be short-term masking and minor behavioral responses. Vessels in close proximity may cause a brief approach or startle response, or may lead to no response at all. Significant impacts on natural behaviors or abandonment of any of the 20 small and resident population areas identified by Baird et al. (2015a) for 11 species of odontocetes would not be anticipated due to exposure to vessel noise associated with testing activities.

Pursuant to the MMPA, vessel noise during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, vessel noise during testing activities as described under Alternative 1 may affect ESA-listed marine mammals but will not affect main Hawaiian Islands Insular false killer whale critical habitat. The Navy will consult with NMFS as required by section 7(a)(2) of the ESA.

3.7.3.1.5.3 Impacts from Vessel Noise under Alternative 2

Impacts from Vessel Noise Under Alternative 2 for Training Activities

Proposed training activities under Alternative 2 that involve vessel movement are approximately the same as compared to Alternative 1 (see Table 3.0-15). The impacts would therefore be the same as those described above in Section 3.7.3.1.5.2 (Impacts from Vessel Noise Under Alternative 1 for Training Activities).

Pursuant to the MMPA, vessel noise during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, vessel noise during training activities as described under Alternative 2 may affect ESA-listed marine mammals but will not affect main Hawaiian Islands Insular false killer whale critical habitat.

Impacts from Vessel Noise Under Alternative 2 for Testing Activities

Proposed testing activities under Alternative 2 that involve vessel movement are approximately the same as compared to Testing Activities proposed under Alternative 1 (see Table 3.0-15). The impacts would therefore be the same as those described above in Section 3.7.3.1.5.2 (Impacts from Vessel Noise Under Alternative 1 for Testing Activities).

Pursuant to the MMPA, vessel noise during testing activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, vessel noise during testing activities as described under Alternative 2 may affect ESA-listed marine mammals but will not affect main Hawaiian Islands Insular false killer whale critical habitat.

3.7.3.1.5.4 Impacts from Vessel Noise Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Based on the analysis presented in Sections 3.7.3.1.5.2 (Impacts from Vessel Noise Under Alternative 1) and 3.7.3.1.5.3 (Impacts from Vessel Noise Under Alternative 2), impacts on individual marine mammals from vessel noise could occur under either action alternative, but impacts on marine mammal populations are not anticipated. Therefore, discontinuing activities involving vessel noise under the No Action Alternative would remove the potential for impacts on individual marine mammals, but would not measurably improve the status of marine mammal populations or otherwise contribute to the recovery of threatened or endangered species that occur in the Study Area.

3.7.3.1.6 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 on 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 (helicopters) produce low-frequency sound and vibration (Pepper et al., 2003). A detailed description of aircraft noise as a stressor is in Section 3.0.3.3.1.5 (Aircraft Overflight Noise).

Sound from aircraft noise, including occasional sonic booms, lack the amplitude or duration to cause any hearing loss in marine mammals underwater (see Section 3.0.3.3.1.5, Aircraft Overflight Noise). Aircraft would pass quickly overhead and rotary-wing aircraft (e.g., helicopters) may hover for a few minutes at a time over the ocean although still for relatively brief periods considering the transient nature of both the aircraft and marine mammals. Due to the brief and dispersed nature of aircraft overflights, masking is also unlikely. Potential impacts from overflight noise are limited to brief behavioral and physiological stress reactions as aircraft passes overhead. Based on the short duration of potential exposure to overflight noise, behavioral and physiological stress reactions, if they did occur, are unlikely to be significant.

3.7.3.1.6.1 Methods for Analyzing Impacts from Aircraft Noise

Potential impacts on marine mammals due to exposure to aircraft noise are analyzed qualitatively. As mentioned above in the summary, behavioral reactions and physiological stress are the only potential impacts on marine mammals from aircraft and missile overflight; therefore, the analysis focuses on the potential for those impacts. The amount of sound entering the water from aircraft is based on measured and modeled levels (see Section 3.0.3.3.1.5, Aircraft Noise). These sound levels, along with the operational characteristics of the aircraft (e.g., altitude, speed), are compared to situations where researchers have observed behavioral responses in marine mammals (see *Behavioral Reactions to Aircraft Overflights* under Section 3.7.3.1.1.5, Behavioral Reactions). The likelihood of behavioral and physiological stress reactions due to Navy aircraft noise is then discussed in light of this research.

3.7.3.1.6.2 Impacts from Aircraft Noise Under Alternative 1

<u>Impacts from Aircraft Noise Under Alternative 1 for Training Activities</u>

Characteristics of aircraft noise are described in Section 3.0.3.3.1 (Acoustic Stressors) and the number of training activities that include aircraft under Alternative 1 are shown in Section 3.0.3.3.4.4 (Aircraft).

Training activities with aircraft would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions).

Marine mammals may respond to both the physical presence and to the noise generated by aircraft, making it difficult to attribute causation to one or the other stimulus. In addition to noise produced, all low-flying aircraft make shadows, which can cause animals at the surface to react. Helicopters may also produce strong downdrafts, a vertical flow of air that becomes a surface wind, which can also affect an animal's behavior at or near the surface.

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors, but significant acoustic energy is primarily transmitted into the water directly below the craft in a narrow cone, as discussed in detail in Appendix D (Acoustic and Explosive Concepts). Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. Section 3.0.3.3.1.5 (Aircraft Overflight Noise) provides additional information on aircraft noise characteristics.

Section 3.7.3.1.1.5 (Behavioral Reactions) reviews research and observations regarding marine mammal behavioral reactions to aircraft overflights; many of the observations cited in this section are of marine mammal reactions to aircraft flown for whale-watching and marine research purposes. Marine mammal survey aircraft are typically used to locate, photograph, track, and sometimes follow animals for long distances or for long periods of time, all of which results in the animal being much more frequently located directly beneath the aircraft (in the cone of the loudest noise and potentially in the shadow of the aircraft) for extended periods. Navy aircraft would not follow marine mammals. In contrast to whale-watching excursions or research efforts, Navy overflights would not result in prolonged exposure of marine mammals to overhead noise or encroachment.

In most cases, exposure of a marine mammal to fixed-wing aircraft or helicopters aircraft presence and noise would last for only seconds as the aircraft quickly passes overhead. Animals would have to be at or near the surface at the time of an overflight to be exposed to appreciable sound levels. Takeoffs and landings occur at established airfields as well as on vessels at sea at unspecified locations across the Study Area. Takeoffs and landings from Navy vessels could startle marine mammals; however, these events only produce in-water noise at any given location for a brief period as the aircraft climbs to cruising altitude. Some sonic booms from aircraft could startle marine mammals, but these events are transient and happen infrequently at any given location within the Study Area. Repeated exposure to most individuals over short periods (days) is extremely unlikely, except for animals that are resident in inshore areas around Navy ports, on Navy fixed ranges (e.g., the Undersea Warfare Training Range), or during major training exercises. These animals could be subjected to multiple overflights per day; however, aircraft would pass quickly overhead, typically at altitudes above 3,000 ft., which would make marine mammals unlikely to respond. No long-term consequences for individuals or populations would be expected.

Low flight altitudes of helicopters during some anti-submarine warfare and mine warfare activities, often under 100 ft., may elicit a somewhat stronger behavioral response due to the proximity to marine mammals, the slower airspeed and therefore longer exposure duration, and the downdraft created by the helicopter's rotor. Marine mammals would likely avoid the area under the helicopter. It is unlikely that an individual would be exposed repeatedly for long periods because these aircraft typically transit open ocean areas within the Study Area. The consensus of all the studies reviewed is that aircraft noise would cause only small temporary changes in the behavior of marine mammals. Specifically, marine mammals at or near the surface when an aircraft flies overhead at low altitude may startle, divert their attention to the aircraft, or avoid the immediate area by swimming away or diving. No more than short-term reactions are likely. No long-term consequences for individuals, species or stocks would be expected.

The reproduction area for humpback whales identified by Baird et al. (2015a) overlaps the Hawaii Range Complex. Aircraft and missile overflight noise from Navy training activities could occur throughout the Study Area. As discussed above for marine mammals overall, behavioral reactions to aircraft and missile overflight noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on humpback whale reproductive behaviors from aircraft and missile overflight noise associated with training activities are unlikely to occur within the reproduction area identified by Baird et al. (2015a).

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex. Aircraft and missile overflight noise from Navy training activities could occur throughout the Study Area. As discussed above for marine mammals overall, behavioral reactions to aircraft and missile overflight noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on blue whale feeding behaviors from aircraft and missile overflight noise associated with training activities are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Range Complex. The identified areas are active altogether during the months of July through March, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Navy training activities could occur year round within the Study Area. As discussed above for marine mammals overall, behavioral reactions to aircraft and missile overflight noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on gray whale migration behaviors from aircraft and missile overflight noise associated with training activities are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015).

Twenty year-round areas for small and resident populations of various species of odontocetes identified by Baird et al. (2015a) are located within the Hawaii Range Complex. These identified areas cover 11 species of odontocetes: dwarf sperm whales (1 area), Blainville's beaked whales (1 area), Cuvier's beaked whales (1 area), pygmy killer whales (1 area), short-finned pilot whales (1 area), melon-headed whales (1 area), false killer whales (1 area), pantropical spotted dolphins (3 areas), spinner dolphins (5 areas), rough-toothed dolphins (1 area), and common bottlenose dolphins (4 areas). Navy training activities could occur year round within the Study Area. As discussed above for marine mammals overall, behavioral reactions to aircraft and missile overflight noise are likely to be brief and minor if they occurred at all. Significant impacts on natural behaviors or abandonment of any of the 20 small and resident population areas identified by Baird et al. (2015a) for 11 species of odontocetes would not be anticipated due to exposure to aircraft and missile overflight noise associated with training activities.

Pursuant to the MMPA, aircraft noise during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, aircraft noise during training activities as described under Alternative 1 may affect ESA-listed marine mammals but will not affect main Hawaiian Islands Insular false killer whale critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Aircraft Noise Under Alternative 1 for Testing Activities

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), testing activities under Alternative 1 include fixed- and rotary-wing aircraft overflights. Certain portions of the Study Area such as areas near Navy airfields, installations, and ranges are used more heavily by Navy aircraft than other portions. Proposed testing activities under Alternative 1 that involve aircraft overflights differ in number and location from training activities under Alternative 1; however, the types and severity of impacts would not be discernible from those described above in Alternative 1 for Testing Activities.

The reproduction area for humpback whales identified by Baird et al. (2015a) overlaps the Hawaii Range Complex within the HSTT Study Area. Navy testing activities could occur year round within the Study Area. As discussed above for marine mammals overall, behavioral reactions to aircraft and missile overflight noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on humpback whale reproductive behaviors from aircraft and missile overflight noise associated with testing activities are unlikely to occur within the reproduction area identified by Baird et al. (2015a).

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area. Navy testing activities could occur year round within the Study Area. As discussed above for marine mammals overall, behavioral reactions to aircraft and missile overflight noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on blue whale feeding behaviors from aircraft and missile overflight noise associated with testing activities are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Range Complex within the Study Area. The identified areas are active altogether during the months of July through March, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Navy testing activities could occur year round within the Study Area. As discussed above for marine mammals overall, behavioral reactions to aircraft and missile overflight noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on gray whale migration behaviors from aircraft and missile overflight noise associated with testing activities are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015).

Twenty areas for small and resident populations of various species of odontocetes identified by Baird et al. (2015a) are located within the Hawaii Range Complex year-round. These identified areas cover 11 species of odontocetes: dwarf sperm whales (1 area), Blainville's beaked whales (1 area), Cuvier's beaked whales (1 area), pygmy killer whales (1 area), short-finned pilot whales (1 area), melon-headed whales (1 area), false killer whales (1 area), pantropical spotted dolphins (3 areas), spinner dolphins (5 areas), rough-toothed dolphins (1 area), and common bottlenose dolphins (4 areas). Navy testing activities could occur year round within the Study Area. As discussed above for marine mammals overall, behavioral reactions to aircraft and missile overflight noise are likely to be brief and minor if they occurred at all. Significant impacts on natural behaviors or abandonment of any of the 20 small and resident population areas identified by Baird et al. (2015a) for 11 species of odontocetes would not be anticipated due to exposure to aircraft and missile overflight noise associated with testing activities.

Pursuant to the MMPA, aircraft noise during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, aircraft noise during testing activities as described under Alternative 1 may affect ESA-listed marine mammals but will not affect main Hawaiian Islands Insular false killer whale critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.7.3.1.6.3 Impacts from Aircraft Noise Under Alternative 2

Impacts from Aircraft Noise Under Alternative 2 for Training Activities

There would be a minor increase in aircraft overflights during training activities under Alternative 2 compared to Alternative 1; however, the types of impacts would not be discernible from those described for training under Alternative 1.

Pursuant to the MMPA, aircraft noise during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, aircraft noise during training activities as described under Alternative 2 may affect ESA-listed marine mammals but will not affect main Hawaiian Islands Insular false killer whale critical habitat.

Impacts from Aircraft Noise Under Alternative 2 for Testing Activities

There would be a minor increase in aircraft overflights under Alternative 2 compared to Alternative 1; however, the types of impacts would not be discernible from those described for testing under Alternative 1.

Pursuant to the MMPA, aircraft noise during testing activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, aircraft noise during testing activities as described under Alternative 2 may affect ESA-listed marine mammals but will not affect main Hawaiian Islands Insular false killer whale critical habitat.

3.7.3.1.6.4 Impacts from Aircraft Noise Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Based on the analysis presented in Sections 3.7.3.1.6.2 (Impacts from Aircraft Noise Under Alternative 1) and 3.7.3.1.6.3 (Impacts from Aircraft Noise Under Alternative 2), impacts on individual marine mammals from activities that produce aircraft noise could occur under either action alternative, but impacts on marine mammal populations are not anticipated. Therefore, discontinuing activities involving aircraft noise under the No Action Alternative would remove the potential for impacts on individual marine mammals, but would not measurably improve the status of marine mammal populations or otherwise contribute to the recovery of threatened or endangered species that occur in the Study Area.

3.7.3.1.7 Impacts from Weapons 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 3.0.3.3.1.6 (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.

Reactions by marine mammals to these specific stressors have not been recorded; however, marine mammals would be expected to react to weapons noise as they would other transient sounds (Section 3.7.3.1.1.5, Behavioral Reactions).

3.7.3.1.7.1 Methods for Analyzing Impacts from Weapons Noise

Potential impacts on marine mammals due to exposure to weapons noise are analyzed qualitatively. Observations of behavioral reactions to these specific types of noise do not exist; however, observations of marine mammal reactions to other impulsive and transient sounds give some indication as to how marine mammals may react to weapons noise. The amount of sound entering the water from various types of weapons noise is based on measured levels (see Section 3.0.3.3.1.6, Weapons Noise). These sound levels are compared to situations where researchers have observed behavioral responses in marine mammals (see Section 3.7.3.1.1.5, Behavioral Reactions). The likelihood of behavioral and physiological stress reactions due to exposure to weapons noise is then discussed in light of this research.

3.7.3.1.7.2 Impacts from Weapons Noise Under Alternative 1

Impacts from Weapons Noise Under Alternative 1 for Training Activities

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapons noise are described in Section 3.0.3.3.6 (Weapons Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for training under Alternative 1 are shown in 3.0.3.3.4.2. (Military Expended Materials). [For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.7.3.2 (Explosive Stressors)].

Use of weapons during training would occur in the range complexes, with greatest use of most types of munitions in within 200 NM of the shore in the Hawaii and Southern California Range Complexes. Most activities involving large-caliber naval gunfire or the launching of targets, missiles, bombs, or other munitions are conducted more than 3 NM from shore. The Navy will implement mitigation measures to avoid or reduce potential impacts from weapons firing noise during large-caliber gunnery activities, as discussed in Section 5.3.2.4 (Weapons Firing Noise).

A gun fired from a ship on the surface of the water propagates a blast wave away from the gun muzzle into the water (see Section 3.0.3.3.1.6, Weapons Noise). Average peak sound pressure in the water measured directly below the muzzle of the gun and under the flight path of the shell (assuming it maintains an altitude of only a few meters above the water's surface) was approximately 200 dB re 1 μPa. Animals at the surface of the water, in a narrow footprint under a weapons trajectory, could be exposed to naval gunfire noise and may exhibit brief startle reactions, avoidance, diving, or no reaction at all. Due to the short-term, transient nature of gunfire noise, animals are unlikely to be exposed multiple times within a short period. Behavioral reactions would likely be short term (minutes) and are unlikely to lead to substantial costs or long-term consequences for individuals, species, or stocks.

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. These sounds would be transient and of short duration, lasting no more than a few seconds at any given location. Many missiles and targets are launched from aircraft, which would produce minimal noise in the water due to the altitude of the aircraft at launch. Missiles and targets launched by ships or near the water's surface may expose marine mammals to levels of sound that could produce brief startle reactions, avoidance, or diving. Due to the short-term, transient nature of launch noise, animals are unlikely to be exposed multiple times within a short period. Behavioral reactions would likely be short-term (minutes) and are unlikely to lead to long-term consequences for individual, species, or stocks.

Some objects, such as hyperkinetic projectiles and non-explosive practice munitions, could impact the water with great force and produce a large impulse (see Section 3.0.3.3.1.6, Weapons Noise). Marine mammals within a few meters could experience some temporary hearing loss, although the probability is low of the non-explosive munitions landing within this range while a marine mammal is near the surface. Animals within the area may hear the impact of non-explosive munitions on the surface of the water and would likely alert, startle, dive, or avoid the immediate area. Significant behavioral reactions from marine mammals would not be expected due to non-explosive munitions impact noise; therefore, long-term consequences for the individual, species, or stocks are unlikely.

Sea otters prefer inland waters and are unlikely to encounter noise from weapons use associated with proposed Navy training activities that typically occur more than 3 NM from shore.

The reproduction area for humpback whales identified by Baird et al. (2015a) overlaps the Hawaii Range Complex. This identified humpback whale reproduction area is mostly in shallow, near-shore waters where the Navy does not typically conduct training activities, especially more intense activities such as major training exercises. Weapons firing, launch, and inert impact noise from Navy training activities could occur throughout the Study Area. As discussed above for marine mammals overall, behavioral reactions to weapons firing, launch, and inert impact noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on humpback whale reproductive behaviors from weapons firing, launch, and inert impact noise associated with training activities are unlikely to occur within the reproduction area identified by Baird et al. (2015a).

Twenty year-round areas for small and resident populations of various species of odontocetes identified by Baird et al. (2015a) are located within the Hawaii Range Complex. These identified areas cover 11 species of odontocetes: dwarf sperm whales (1 area), Blainville's beaked whales (1 area), Cuvier's beaked whales (1 area), pygmy killer whales (1 area), short-finned pilot whales (1 area), melon-headed whales (1 area), false killer whales (1 area), pantropical spotted dolphins (3 areas), spinner dolphins (5 areas), rough-toothed dolphins (1 area), and common bottlenose dolphins (4 areas). Most of these identified small and resident population areas are located outside of the areas with significant Navy weapon firing activity. Weapons firing, launch, and inert impact noise from Navy training activities could occur throughout the Study Area. As discussed above for marine mammals overall, behavioral reactions to weapons firing, launch, and inert impact noise are likely to be brief and minor if they occurred at all. Significant impacts on natural behaviors or abandonment of any of the 20 small and resident population areas identified by Baird et al. (2015a) for 11 species of odontocetes would not be anticipated due to exposure to weapons firing, launch, and inert impact noise associated with training activities.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area.

However, these feeding areas make up a very small portion of the Study Area. Weapons firing, launch, and inert impact noise from Navy training activities could occur throughout the Study Area. As discussed above for marine mammals overall, behavioral reactions to weapons firing, launch, and inert impact noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on blue whale feeding behaviors from weapons firing, launch, and inert impact noise associated with training activities are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Range Complex within the Study Area. The identified areas are active altogether during the months of July through March, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Weapons firing, launch, and inert impact noise from Navy training activities could occur throughout the Study Area. As discussed above for marine mammals overall, behavioral reactions to weapons firing, launch, and inert impact noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on gray whale migration behaviors from weapons firing, launch, and inert impact noise associated with training activities are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015).

Pursuant to the MMPA, weapons noise during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, weapons noise during training activities as described under Alternative 1 may affect ESA-listed marine mammals and main Hawaiian Islands Insular false killer whale critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Weapons Noise Under Alternative 1 for Testing Activities

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapons noise are described in Section 3.0.3.3.6 (Weapons Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for testing under Alternative 1 are shown in 3.0.3.3.4.2. (Military Expended Materials). [For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.7.3.2 (Explosive Stressors)].

Use of weapons during testing would typically occur on the range complexes, with some activity also occurring on testing ranges. Most activities involving large-caliber naval gunfire or the launching of targets, missiles, bombs, or other munitions are conducted more than 3 NM from shore. The Navy will implement mitigation measures to avoid or reduce potential impacts from weapons firing noise during large-caliber gunnery activities, as discussed in Section 5.3.2.4 (Weapons Firing Noise).

The associated impacts would differ in quantity and location from training activities; however, the types and severity of impacts would not be discernible from those described above for training activities.

The reproduction area for humpback whales identified by Baird et al. (2015) overlaps the Hawaii Range Complex within the HSTT Study Area. This identified humpback whale reproduction area is mostly in shallow, near-shore waters where the Navy does not typically conduct testing activities. Weapons noise from Navy testing activities could occur throughout the Study Area. As discussed above for marine mammals overall, behavioral reactions to weapons firing, launch, and inert impact noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on humpback whale reproductive behaviors from weapons firing, launch, and inert impact noise associated with testing activities are unlikely to occur within the reproduction area identified by Baird et al. (2015).

Twenty areas for small and resident populations of various species of odontocetes identified by Baird et al. (2015) are located within the Hawaii Range Complex year-round. These identified areas cover 11 species of odontocetes: dwarf sperm whales (1 area), Blainville's beaked whales (1 area), Cuvier's beaked whales (1 area), pygmy killer whales (1 area), short-finned pilot whales (1 area), melon-headed whales (1 area), false killer whales (1 area), pantropical spotted dolphins (3 areas), spinner dolphins (5 areas), rough-toothed dolphins (1 area), and common bottlenose dolphins (4 areas). Most of these identified small and resident population areas are located outside of the areas where Navy weapons firing testing occurs. Significant impacts on natural behaviors or abandonment of any of the 20 small and resident population areas identified by Baird et al. (2015) for 11 species of odontocetes would not be anticipated due to exposure to weapons firing, launch, and inert impact noise associated with testing activities.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area. However, these feeding areas make up a very small portion of the Study Area. Weapons firing, launch, and inert impact noise from Navy testing activities could occur throughout the Study Area. As discussed above for marine mammals overall, behavioral reactions to weapons firing, launch, and inert impact noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on blue whale feeding behaviors from weapons firing, launch, and inert impact noise associated with testing activities are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Range Complex within the Study Area. The identified areas are active altogether during the months of July through March, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Weapons firing, launch, and inert impact noise from Navy testing activities could occur throughout the Study Area. As discussed above for marine mammals overall, behavioral reactions to weapons firing, launch, and inert impact noise are likely to be brief and minor if they occurred at all. Therefore, significant impacts on gray whale migration behaviors from weapons firing, launch, and inert impact noise associated with testing activities are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015).

Pursuant to the MMPA, weapons noise during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, weapons noise during testing activities as described under Alternative 1 may affect ESA-listed marine mammals and main Hawaiian Islands Insular false killer whale critical habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.7.3.1.7.3 Impacts from Weapons Noise Under Alternative 2

<u>Impacts from Weapons Under Alternative 2 for Training Activities</u>

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapons noise are described in Section 3.0.3.3.6 (Weapons Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for training under Alternative 2 are shown in 3.0.3.3.4.2. (Military Expended Materials) [For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.7.3.2 (Explosive Stressors)].

There would be a minor increase in these activities under Alternative 2 compared to Alternative 1; however, the types and severity of impacts would not be discernible from those described above in Impacts from Aircraft Noise Under Alternative 1 for Training Activities.

Pursuant to the MMPA, weapons noise during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, weapons noise during training activities as described under Alternative 2 may affect ESA-listed marine mammals and main Hawaiian Islands Insular false killer whale critical habitat.

Impacts from Weapons Noise Under Alternative 2 for Testing Activities

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapons noise are described in Section 3.0.3.3.6 (Weapons Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for testing under Alternative 2 are shown in 3.0.3.3.4.2. (Military Expended Materials) [For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.7.3.2 (Explosive Stressors)].

There would be a minor increase in these activities under Alternative 2 compared to Alternative 1; however, the types and severity of impacts would not be discernible from those described above in Impacts from Aircraft Noise Under Alternative 1 for Training Activities.

Pursuant to the MMPA, weapons noise during testing activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities.

Pursuant to the ESA, weapons noise during testing activities as described under Alternative 2 may affect ESA-listed marine mammals and main Hawaiian Islands Insular false killer whale critical habitat.

3.7.3.1.7.4 Impacts from Weapons Noise Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Based on the analysis presented in Sections 3.7.3.1.7.2 (Impacts from Weapons Noise Under Alternative 1) and 3.7.3.1.7.3 (Impacts from Weapons Noise Under Alternative 2), impacts on individual marine mammals from activities that produce weapons noise could occur under either alternative, but impacts on marine mammal populations are not anticipated. Therefore, discontinuing activities that involve weapons noise under the No Action Alternative would remove the potential for impacts on individual marine mammals, but would not measurably improve the status of marine mammal populations or otherwise contribute to the recovery of threatened or endangered species that occur in the Study Area.

3.7.3.2 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 the Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors (Section 3.0.3.6.1). The following Background section discusses what is currently known about explosive effects to marine mammals.

3.7.3.2.1 Background

3.7.3.2.1.1 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. The Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors (see Section 3.0.3.6.1) 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 Explosive 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 to 150 long-beaked common dolphins entered the mitigation zone surrounding an area where a time-delayed firing device had been initiated, that could not be deactivated, on an explosive with a net explosive weight (NEW) of 8.76 pounds (lb.) (3.97 kilograms [kg]) placed at a depth of 48 ft. (14.6 m).

Although the dive boat was placed between the pod and the explosive in an effort to guide the dolphins away from the area, that effort was unsuccessful. Approximately 1 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 3 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.

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 threshold shift or other auditory effects (see Section 3.7.3.2.1.2, 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 to 27 psi-ms (170 to 190 Pa-s). Lung injuries were found to be slightly more prevalent than GI 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. 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. 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). 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 GI 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.

3.7.3.2.1.2 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. The Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors (see Section 3.0.3.6.1) 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 Hearing Loss under Acoustic Stressors above (see Section 3.7.3.1.1.2).

3.7.3.2.1.3 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). The Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities (see Section 3.0.3.6.1) 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 Physiological Stress under Acoustic Stressors above (see Section 3.7.3.1.1.3, Physiological Stress). 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.

3.7.3.2.1.4 Masking

Masking occurs when one sound, distinguished as the “noise,” interferes with the detection or recognition of another sound. The quantitative definition of masking is the amount in decibels an auditory detection or discrimination threshold is raised in the presence of a masker (Erbe et al., 2016). As discussed in the Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors (Section 3.0.3.6.1), 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 may lead to a change in vocalizations or a change in behavior (e.g., cessation of foraging, leaving an area).

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 Masking under Acoustic Stressors above (see Section 3.7.3.1.1.4, Masking). Potential masking from explosive sounds is likely to be similar to masking studied for other impulsive sounds such as air guns.

3.7.3.2.1.5 Behavioral Reactions

As discussed in the Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors (Section 3.0.3.6.1), 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 s of the explosion) was an increase in whistles relative to the 30 s 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). Behavioral reactions from explosive sounds are likely to be similar to reactions studied for other impulsive sounds such as those produced by air guns. 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. Most data has 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 air gun data (as presented in 3.7.3.1 Acoustic Stressors) provides the best available science for assessing behavioral responses to impulsive sounds (i.e., sounds from explosives) by marine mammals, it is likely that these responses represent a worst-case scenario compared to most Navy explosive noise sources.

General research findings regarding behavioral reactions from marine mammals due to exposure to impulsive sounds, such as those associated with explosions, are discussed in detail in Behavioral Reactions under Acoustic Stressors above (see Section 3.7.3.1.1.5, Behavioral Reactions).

3.7.3.2.1.6 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).

3.7.3.2.1.7 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 Conceptual Framework for Assessing Effects from Acoustic and Explosive Stressors (Section 3.0.3.6.1). 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 measureable 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.

3.7.3.2.2 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 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 explosions could also mask biologically important sounds; however, the duration of individual sounds is very short, reducing the likelihood of substantial auditory masking.

3.7.3.2.2.1 Methods for Analyzing Impacts from Explosives

The Navy performed a quantitative analysis to estimate the number 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 animals that 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 (Marine Species Density Database), which takes into account:

- criteria and thresholds used to predict impacts from explosives (see below)
- the density and spatial distribution of marine mammals
- 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*.

Criteria and Thresholds used to Estimate Impacts on Marine Mammals from Explosives

See the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* technical report (U.S. Department of the Navy, 2017a) for detailed information on how the criteria and thresholds were derived.

Mortality and Injury from Explosives

As discussed above in Section 3.7.3.2.1.1 (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 3.7-57). The thresholds for the farthest range to effect are based on the received level at which one percent risk 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, 2017a).

Table 3.7-57: 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]	$65.8M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$	$65.8M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$
	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: dB re 1 µPa = decibels referenced to 1 micropascal, 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 threshold 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 3.7-94). 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. Auditory weighting functions for all species groups are presented in Figure 3.7-94.

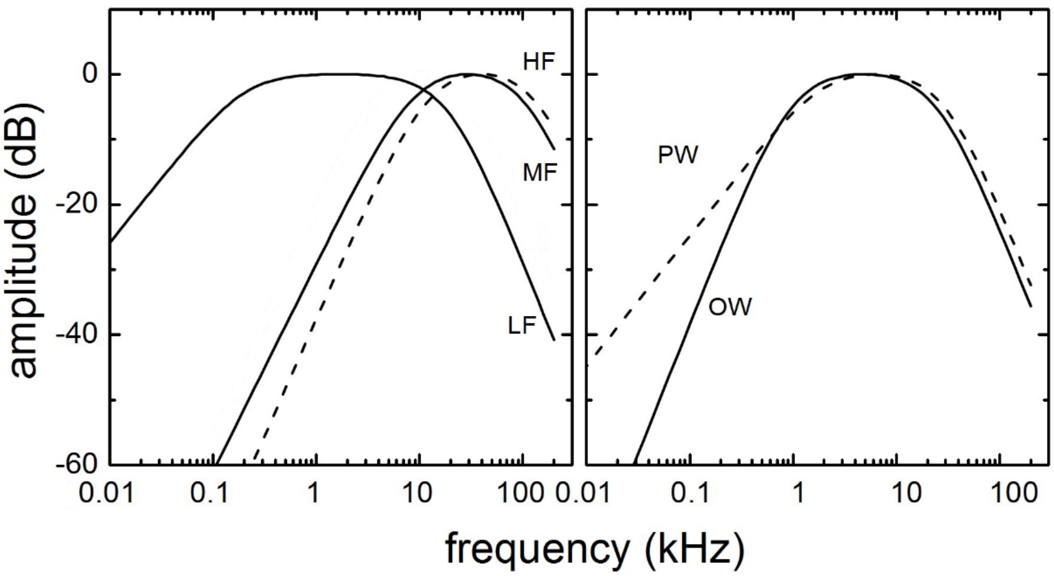


Figure 3.7-94: Navy Phase III Weighting Functions for all Species Groups

Notes: For parameters used to generate the functions and more information on weighting function derivation see (Finneran, 2015). MF = Mid-Frequency Cetacean; HF = High-Frequency Cetacean; LF = Low-Frequency Cetacean; PW = Phocid (in-water); OW = Otariid (in-water)

Hearing Loss from Explosives

Criteria used to define threshold shifts 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 (see Figure 3.7-95).

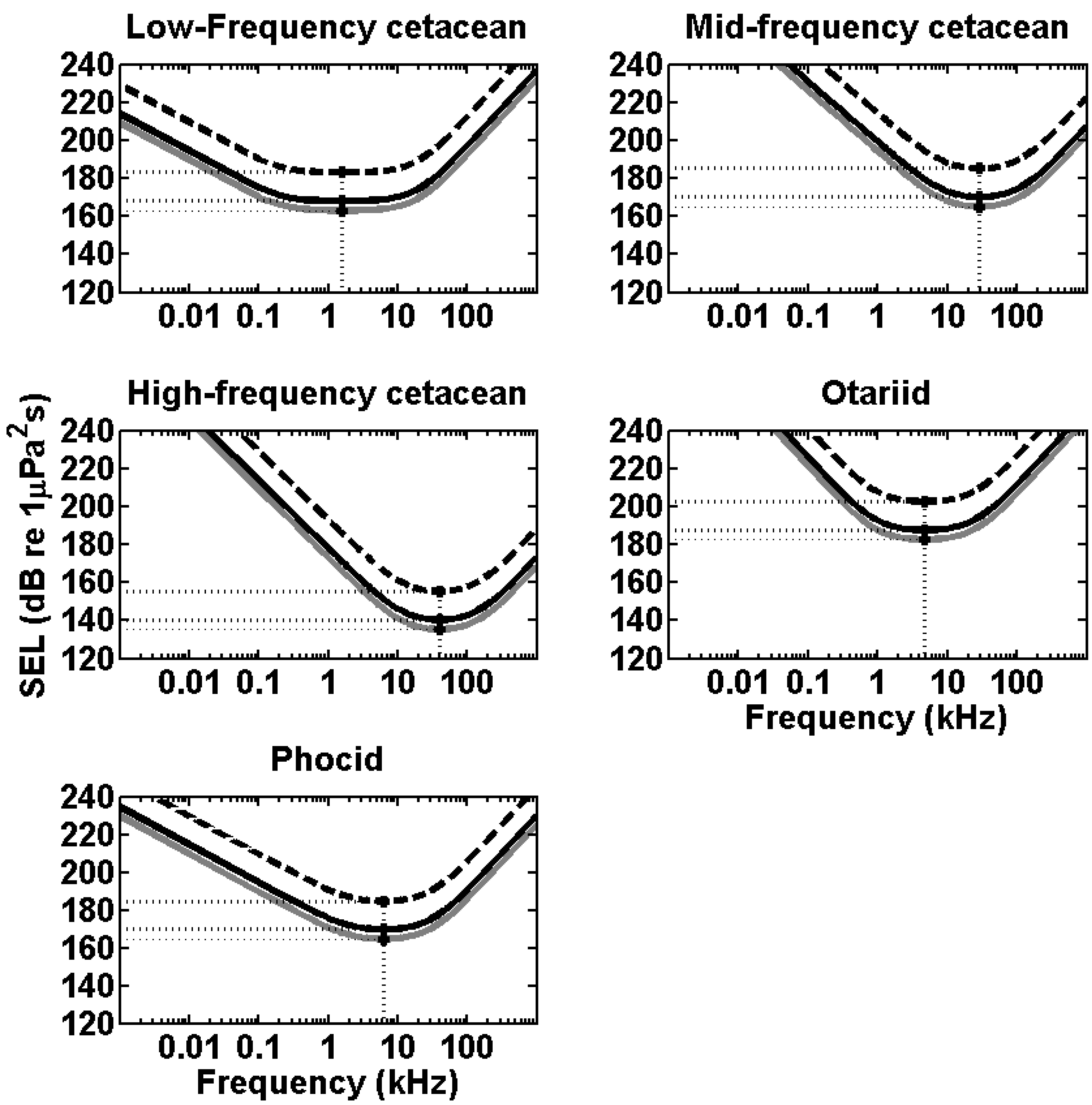


Figure 3.7-95: Navy Phase III Behavioral, TTS and PTS Exposure Functions for Explosives

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).

Table 3.7-58: 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	163	168	213	183	219
Mid-frequency Cetacean	165	170	224	185	230
High-frequency Cetacean	135	140	196	155	202
Otariids in water	183	188	226	203	232
Phocid seal in water	165	170	212	185	218

Notes: dB = decibels; PTS = permanent threshold shift; SEL = sound exposure level; SPL = sound pressure level; TTS = temporary threshold shift

Behavioral Responses from Explosives

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. For exercises with multiple explosions, the behavioral threshold used in this analysis is 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).

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). For single explosions at received sound levels below hearing loss thresholds, the most likely behavioral response is a brief alerting or orienting response. 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 Federal Register 230; 66 Federal Register 87; 73 Federal Register 143) and is extended to the criteria used in this analysis.

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 quantifies 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 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.

In the quantitative analysis, consideration of mitigation measures means that, for activities that implement mitigation, model-estimated mortality is considered mitigated to the level of injury. 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. For example, based on small boat surveys between 2000 and 2012 in the Hawaiian Islands, pantropical spotted dolphins and striped dolphins were frequently observed leaping out of the water and Cuvier's beaked whales (Baird, 2013a) and Blainville's beaked whales (HDR, 2012) were occasionally observed breaching. These behaviors are visible from a great distance and likely increase sighting distances and detections of these species. Environmental conditions under which the training or testing activity could take place are also considered such as the sea surface conditions, weather (e.g., fog or rain), and day versus night.

The Navy also implements mitigation measures for certain explosive activities within mitigation areas, as described in Section 5.4 (Mitigation Areas to be Implemented). The benefits of mitigation areas are discussed qualitatively and have not been factored into the quantitative analysis process or reductions in take for the MMPA and ESA impact estimates. Mitigation areas are designed to help avoid or reduce impacts during biologically important life processes within particularly important habitat areas. Therefore, mitigation area benefits are discussed in terms of the context of impact avoidance or reduction.

3.7.3.2.2.2 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 (Section 3.7.3.2.2.1, Criteria and Thresholds Used to Estimate Impacts on Marine Mammals from Explosives) and the explosive propagation calculations from the Navy Acoustic Effects Model (Section 3.7.3.2.2.1, Navy Acoustic Effects Model). The range to effects are shown for a range of explosive bins (Section 3.7.3.2.2.2, Impact Ranges from Explosives), from E1 (up to 0.25 lb. net explosive weight) to E12 (up to 1,000 lb. net explosive weight). 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 be mitigated within applicable mitigation zones.

Table 3.7-59 shows the minimum, average, and maximum ranges due to varying propagation conditions to non-auditory injury based on the larger of the range to slight lung injury or gastrointestinal tract injury for representative animal masses ranging from 5 to 72,000 kg and different explosive bins ranging from 0.25 to 1,000 lb. net explosive weight. 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 3.7-60.

Table 3.7-59: Ranges[1] to Non-Auditory Injury for All Marine Mammal Hearing Groups

Bin	*Range (m)*
E1	12 (11–13)
E2	15 (15–20)
E3	25 (25–30)
E4	32 (0–75)
E5	40 (35–140)
E6	52 (40–120)
E7	145 (100–500)
E8	117 (75–400)
E9	120 (90–290)
E10	174 (100–480)
E11	443 (350–1,775)
E12	232 (110–775)

Note: All ranges to non-auditory injury within this table are driven by GI tract injury thresholds regardless of animal mass.

Table 3.7-60: Ranges[1] to Mortality Risk for All Marine Mammal Hearing Groups as a Function of Animal Mass

Bin	*Animal Mass Intervals (kg)*[1]					
	10	***250***	***1,000***	***5,000***	***25,000***	***72,000***
E1	3 (2–3)	0 (0–3)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
E2	4 (3–5)	1 (0–4)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
E3	8 (6–10)	4 (2–8)	1 (0–2)	0 (0–0)	0 (0–0)	0 (0–0)
E4	15 (0–35)	9 (0–30)	4 (0–8)	2 (0–6)	0 (0–3)	0 (0–2)
E5	13 (11–45)	7 (4–35)	3 (3–12)	2 (0–8)	0 (0–2)	0 (0–2)
E6	18 (14–55)	10 (5–45)	5 (3–15)	3 (2–10)	0 (0–3)	0 (0–2)
E7	67 (55–180)	35 (18–140)	16 (12–30)	10 (8–20)	5 (4–9)	4 (3–7)
E8	50 (24–110)	27 (9–55)	13 (0–20)	9 (4–13)	4 (0–6)	3 (0–5)
E9	32 (30–35)	20 (13–30)	10 (8–12)	7 (6–9)	4 (3–4)	3 (2–3)
E10	56 (40–190)	25 (16–130)	13 (11–16)	9 (7–11)	5 (4–5)	4 (3–4)
E11	211 (180–500)	109 (60–330)	47 (40–100)	30 (25–65)	15 (0–25)	13 (11–22)
E12	94 (50–300)	35 (20–230)	16 (13–19)	11 (9–13)	6 (5–8)	5 (4–8)

[1]Average distance (m) to mortality is depicted above the minimum and maximum distances which are in parentheses.

The following tables (Table 3.7-61 through Table 3.7-70) show the minimum, average, and maximum ranges to onset of auditory and behavioral effects based on the thresholds described in Section 3.7.3.2.2.1 (Criteria and Thresholds Used to Estimate Impacts on Marine Mammals from Explosives). Ranges are provided for a representative source depth and cluster size 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.

Table 3.7-61: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for High-Frequency Cetaceans

Range to Effects for Explosives: High Frequency Cetacean[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E1	0.1	1	353 (130–825)	1,234 (290–3,025)	2,141 (340–4,775)
		25	1,188 (280–3,025)	3,752 (490–8,525)	5,196 (675–12,275)
E2	0.1	1	425 (140–1,275)	1,456 (300–3,525)	2,563 (390–5,275)
		10	988 (280–2,275)	3,335 (480–7,025)	4,693 (650–10,275)
E3	0.1	1	654 (220–1,525)	2,294 (350–4,775)	3,483 (490–7,775)
		12	1,581 (300–3,525)	4,573 (650–10,275)	6,188 (725–14,775)
	18.25	1	747 (550–1,525)	3,103 (950–6,025)	5,641 (1,000–9,275)
		12	1,809 (875–4,025)	7,807 (1,025–12,775)	10,798 (1,025–17,775)
E4	3	2	2,020 (1,025–3,275)	3,075 (1,025–6,775)	3,339 (1,025–9,775)
	15.25	2	970 (600–1,525)	4,457 (1,025–8,525)	6,087 (1,275–12,025)
	19.8	2	1,023 (1,000–1,025)	4,649 (2,275–8,525)	6,546 (3,025–11,025)
	198	2	959 (875–1,525)	4,386 (3,025–7,525)	5,522 (3,025–9,275)
E5	0.1	25	2,892 (440–6,275)	6,633 (725–16,025)	8,925 (800–22,775)
	15.25	25	4,448 (1,025–7,775)	10,504 (1,525–18,275)	13,605 (1,775–24,775)
E6	0.1	1	1,017 (280–2,525)	3,550 (490–7,775)	4,908 (675–12,275)
	3	1	2,275 (2,025–2,525)	6,025 (4,525–7,275)	7,838 (6,275–9,775)
	15.25	1	1,238 (625–2,775)	5,613 (1,025–10,525)	7,954 (1,275–14,275)
E7	3	1	3,150 (2,525–3,525)	7,171 (5,525–8,775)	8,734 (7,275–10,525)
	18.25	1	2,082 (925–3,525)	6,170 (1,275–10,525)	8,464 (1,525–16,525)
E8	0.1	1	1,646 (775–2,525)	4,322 (1,525–9,775)	5,710 (1,525–14,275)
	45.75	1	1,908 (1,025–4,775)	5,564 (1,525–12,525)	7,197 (1,525–18,775)

Table 3.7-61: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for High-Frequency Cetaceans (continued)

Range to Effects for Explosives: High Frequency Cetacean[1]					
Bin	Source Depth (m)	Cluster Size	PTS	TTS	Behavioral
E9	0.1	1	2,105 (850–4,025)	4,901 (1,525–12,525)	6,700 (1,525–16,775)
E10	0.1	1	2,629 (875–5,275)	5,905 (1,525–13,775)	7,996 (1,525–20,025)
E11	18.5	1	3,034 (1,025–6,025)	7,636 (1,525–16,525)	9,772 (1,775–21,525)
	45.75	1	2,925 (1,525–6,025)	7,152 (2,275–18,525)	9,011 (2,525–24,525)
E12	0.1	1	2,868 (975–5,525)	6,097 (2,275–14,775)	8,355 (4,275–21,275)
		3	3,762 (1,525–8,275)	7,873 (3,775–20,525)	10,838 (4,275–26,525)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.

Table 3.7-62: Peak Pressure Based Ranges to Onset PTS and Onset TTS for High-Frequency Cetaceans

Range to Effects for Explosives: High Frequency Cetacean[1]			
Bin	Source Depth (m)	PTS	TTS
E1	0.1	660 (170–1,025)	1,054 (270–1,775)
E2	0.1	806 (190–2,025)	1,280 (300–6,025)
E3	0.1	1,261 (290–6,025)	2,068 (480–9,025)
	18.25	1,615 (925–5,275)	2,813 (1,025–6,775)
E4	3	2,466 (1,025–4,025)	2,823 (1,025–4,275)
	15.25	2,524 (1,025–6,525)	4,955 (1,775–11,025)
	19.8	2,113 (1,275–3,025)	3,570 (1,775–6,275)
	198	3,682 (2,275–7,025)	5,586 (3,025–11,275)
E5	0.1	1,869 (410–7,775)	2,751 (600–13,275)
	15.25	2,908 (1,525–7,775)	5,291 (2,025–11,775)

Table 3.7-62: Peak Pressure Based Ranges to Onset PTS and Onset TTS for High-Frequency Cetaceans (continued)

Range to Effects for Explosives: High Frequency Cetacean[1]			
Bin	Source Depth (m)	PTS	TTS
E6	0.1	2,177 (525–9,275)	3,136 (625–14,025)
	3	2,817 (2,525–3,525)	4,817 (4,025–5,775)
	15.25	4,061 (1,775–11,275)	6,726 (2,025–16,775)
E7	3	4,525 (3,775–5,275)	6,171 (5,525–7,525)
	18.25	5,496 (2,525–12,775)	8,114 (3,025–14,275)
E8	0.1	2,986 (925–5,775)	3,806 (1,525–9,775)
	45.75	4,916 (1,525–13,525)	7,111 (2,275–27,775)
E9	0.1	3,365 (1,275–8,025)	4,409 (1,525–13,525)
E10	0.1	3,791 (1,275–9,775)	5,540 (1,775–26,025)
E11	18.5	10,062 (4,025–23,025)	13,369 (5,025–33,025)
	45.75	7,635 (2,275–31,025)	12,673 (3,775–37,775)
E12	0.1	4,110 (1,525–13,525)	5,603 (2,025–21,775)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 3.7-63: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Low-Frequency Cetaceans

Range to Effects for Explosives: Low Frequency Cetacean[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E1	0.1	1	51 (40–70)	227 (100–320)	124 (70–160)
		25	205 (95–270)	772 (270–1,275)	476 (190–725)
E2	0.1	1	65 (45–95)	287 (120–400)	159 (80–210)
		10	176 (85–240)	696 (240–1,275)	419 (160–625)
E3	0.1	1	109 (65–150)	503 (190–1,000)	284 (120–430)
		12	338 (130–525)	1,122 (320–7,775)	761 (240–6,025)
	18.25	1	205 (170–340)	996 (410–2,275)	539 (330–1,275)
		12	651 (340–1,275)	3,503 (600–8,275)	1,529 (470–3,275)
E4	3	2	493 (440–1,000)	2,611 (1,025–4,025)	1,865 (950–2,775)
	15.25	2	583 (350–850)	3,115 (1,275–5,775)	1,554 (1,000–2,775)
	19.8	2	378 (370–380)	1,568 (1,275–1,775)	926 (825–950)
	198	2	299 (290–300)	2,661 (1,275–3,775)	934 (900–950)
E5	0.1	25	740 (220–6,025)	2,731 (460–22,275)	1,414 (350–14,275)
	15.25	25	1,978 (1,025–5,275)	8,188 (3,025–19,775)	4,727 (1,775–11,525)
E6	0.1	1	250 (100–420)	963 (260–7,275)	617 (200–1,275)
	3	1	711 (525–825)	3,698 (1,525–4,275)	2,049 (1,025–2,525)
	15.25	1	718 (390–2,025)	3,248 (1,275–8,525)	1,806 (950–4,525)
E7	3	1	1,121 (850–1,275)	5,293 (2,025–6,025)	3,305 (1,275–4,025)
	18.25	1	1,889 (1,025–2,775)	6,157 (2,775–11,275)	4,103 (2,275–7,275)
E8	0.1	1	460 (170–950)	1,146 (380–7,025)	873 (280–3,025)
	45.75	1	1,049 (550–2,775)	4,100 (1,025–14,275)	2,333 (800–7,025)

Table 3.7-63: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Low-Frequency Cetaceans (continued)

Range to Effects for Explosives: Low Frequency Cetacean[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E9	0.1	1	616 (200–1,275)	1,560 (450–12,025)	1,014 (330–5,025)
E10	0.1	1	787 (210–2,525)	2,608 (440–18,275)	1,330 (330–9,025)
E11	18.5	1	4,315 (2,025–8,025)	10,667 (4,775–26,775)	7,926 (3,275–21,025)
	45.75	1	1,969 (775–5,025)	9,221 (2,525–29,025)	4,594 (1,275–16,025)
E12	0.1	1	815 (250–3,025)	2,676 (775–18,025)	1,383 (410–8,525)
	0.1	3	1,040 (330–6,025)	4,657 (1,275–31,275)	2,377 (700–16,275)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.

Table 3.7-64: Peak Pressure Based Ranges to Onset PTS and Onset TTS for Low-Frequency Cetaceans

Range to Effects for Explosives: Low Frequency Cetacean[1]			
Bin	Source Depth (m)	PTS	TTS
E1	0.1	126 (55–140)	226 (90–270)
E2	0.1	161 (65–180)	280 (100–340)
E3	0.1	264 (100–320)	453 (140–600)
	18.25	330 (240–875)	614 (330–1,775)
E4	3	531 (420–625)	916 (650–2,025)
	15.25	525 (350–725)	864 (550–1,275)
	19.8	390 (370–400)	730 (650–800)
	198	379 (340–400)	746 (675–1,525)
E5	0.1	404 (130–525)	679 (180–1,025)
	15.25	547 (360–1,275)	991 (675–1,525)
E6	0.1	496 (150–700)	797 (210–6,025)
	3	817 (650–975)	1,317 (1,025–1,775)
	15.25	735 (420–1,275)	1,266 (875–2,525)
E7	3	1,017 (925–1,025)	1,977 (1,775–2,275)
	18.25	1,246 (875–1,775)	2,368 (1,525–3,775)
E8	0.1	830 (260–1,275)	1,045 (360–1,775)
	45.75	1,306 (550–3,775)	2,008 (675–6,025)
E9	0.1	966 (310–1,525)	1,240 (420–2,525)
E10	0.1	1,057 (330–1,775)	1,447 (450–6,025)
E11	18.5	2,945 (1,025–7,525)	5,497 (2,025–12,525)
	45.75	2,023 (700–6,775)	2,779 (775–11,275)
E12	0.1	1,155 (390–2,025)	1,512 (550–3,775)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 3.7-65: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Mid-Frequency Cetaceans

Range to Effects for Explosives: Mid-Frequency Cetacean[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E1	0.1	1	25 (25–25)	118 (80–210)	178 (100–320)
		25	107 (75–170)	476 (150–1,275)	676 (240–1,525)
E2	0.1	1	30 (30–35)	145 (95–240)	218 (110–400)
		10	88 (65–130)	392 (140–825)	567 (190–1,275)
E3	0.1	1	50 (45–65)	233 (110–430)	345 (130–600)
		12	153 (90–250)	642 (220–1,525)	897 (270–2,025)
	18.25	1	38 (35–40)	217 (190–900)	331 (290–850)
		12	131 (120–250)	754 (550–1,525)	1,055 (600–2,525)
E4	3	2	139 (110–160)	1,069 (525–1,525)	1,450 (875–1,775)
	15.25	2	71 (70–75)	461 (400–725)	613 (470–750)
	19.8	2	69 (65–70)	353 (350–360)	621 (600–650)
	198	2	49 (0–55)	275 (270–280)	434 (430–440)
E5	0.1	25	318 (130–625)	1,138 (280–3,025)	1,556 (310–3,775)
	15.25	25	312 (290–725)	1,321 (675–2,525)	1,980 (850–4,275)
E6	0.1	1	98 (70–170)	428 (150–800)	615 (210–1,525)
	3	1	159 (150–160)	754 (650–850)	1,025 (1,025–1,025)
	15.25	1	88 (75–180)	526 (450–875)	719 (500–1,025)
E7	3	1	240 (230–260)	1,025 (1,025–1,025)	1,900 (1,775–2,275)
	18.25	1	166 (120–310)	853 (500–1,525)	1,154 (550–1,775)
E8	0.1	1	160 (150–170)	676 (500–725)	942 (600–1,025)
	45.75	1	128 (120–170)	704 (575–2,025)	1,040 (750–2,525)
E9	0.1	1	215 (200–220)	861 (575–950)	1,147 (650–1,525)

Table 3.7-65: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Mid-Frequency Cetaceans (continued)

Range to Effects for Explosives: Mid-Frequency Cetacean[1]					
Bin	Source Depth (m)	Cluster Size	PTS	TTS	Behavioral
E10	0.1	1	275 (250–480)	1,015 (525–2,275)	1,424 (675–3,275)
E11	18.5	1	335 (260–500)	1,153 (650–1,775)	1,692 (775–3,275)
	45.75	1	272 (230–825)	1,179 (825–3,025)	1,784 (1,000–4,275)
E12	0.1	1	334 (310–350)	1,151 (700–1,275)	1,541 (800–3,525)
	0.1	3	520 (450–550)	1,664 (800–3,525)	2,195 (925–4,775)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.

Table 3.7-66: Peak Pressure Based Ranges to Onset PTS and Onset TTS for Mid-Frequency Cetaceans

Range to Effects for Explosives: Mid-Frequency Cetacean[1]			
Bin	**Source Depth (m)**	**PTS**	**TTS**
E1	0.1	43 (35–45)	81 (45–95)
E2	0.1	57 (40–65)	102 (50–110)
E3	0.1	96 (50–110)	174 (65–210)
	18.25	101 (100–130)	196 (180–725)
E4	3	261 (180–300)	421 (250–460)
	15.25	162 (120–290)	328 (240–725)
	19.8	120 (120–120)	240 (240–240)
	198	117 (80–120)	229 (210–230)
E5	0.1	149 (65–160)	272 (95–300)
	15.25	178 (160–430)	358 (290–825)
E6	0.1	188 (70–230)	338 (110–400)
	3	268 (230–360)	527 (410–625)
	15.25	240 (200–460)	479 (400–725)
E7	3	459 (320–625)	730 (575–900)
	18.25	429 (310–550)	676 (550–800)
E8	0.1	337 (300–370)	580 (400–750)
	45.75	431 (340–1,025)	806 (600–2,275)
E9	0.1	450 (350–525)	757 (450–1,025)
E10	0.1	534 (240–700)	902 (410–1,275)
E11	18.5	896 (725–1,025)	1,577 (1,025–2,275)
	45.75	824 (600–2,775)	1,484 (900–4,775)
E12	0.1	669 (430–925)	1,074 (525–1,525)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 3.7-67: SEL Based Ranges to Onset PTS and Onset TTS for Otariids

Range to Effects for Explosives: Otariids[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E1	0.1	1	7 (7–7)	34 (30–40)	56 (45–70)
		25	30 (25–35)	136 (80–180)	225 (100–320)
E2	0.1	1	9 (9–9)	41 (35–55)	70 (50–95)
		10	25 (25–30)	115 (70–150)	189 (95–250)
E3	0.1	1	16 (15–19)	70 (50–95)	115 (70–150)
		12	45 (35–65)	206 (100–290)	333 (130–450)
	18.25	1	15 (15–15)	95 (90–100)	168 (150–310)
		12	55 (50–60)	333 (280–750)	544 (440–1,025)
E4	3	2	64 (40–85)	325 (240–340)	466 (370–490)
	15.25	2	30 (30–35)	205 (170–300)	376 (310–575)
	19.8	2	25 (25–25)	170 (170–170)	290 (290–290)
	198	2	17 (0–25)	117 (110–120)	210 (210–210)
E5	0.1	25	98 (60–120)	418 (160–575)	626 (240–1,000)
	15.25	25	151 (140–260)	750 (650–1,025)	1,156 (975–2,025)
E6	0.1	1	30 (25–35)	134 (75–180)	220 (100–320)
	3	1	53 (50–55)	314 (280–390)	459 (420–525)
	15.25	1	36 (35–40)	219 (200–380)	387 (340–625)
E7	3	1	93 (90–100)	433 (380–500)	642 (550–800)
	18.25	1	73 (70–75)	437 (360–525)	697 (600–850)
E8	0.1	1	50 (50–50)	235 (220–250)	385 (330–450)
	45.75	1	55 (55–60)	412 (310–775)	701 (500–1,525)
E9	0.1	1	68 (65–70)	316 (280–360)	494 (390–625)
E10	0.1	1	86 (80–95)	385 (240–460)	582 (390–800)

Table 3.7-67: SEL Based Ranges to Onset PTS and Onset TTS for Otariids (continued)

Range to Effects for Explosives: Otariids[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E11	18.5	1	158 (150–200)	862 (750–975)	1,431 (1,025–2,025)
	45.75	1	117 (110–130)	756 (575–1,525)	1,287 (950–2,775)
E12	0.1	1	104 (100–110)	473 (370–575)	709 (480–1,025)
	0.1	3	172 (170–180)	694 (480–1,025)	924 (575–1,275)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.

Table 3.7-68: Peak Pressure Based Ranges to Onset PTS and Onset TTS for Otariids

Range to Effects for Explosives: Otariids[1]			
Bin	**Source Depth (m)**	**PTS**	**TTS**
E1	0.1	35 (30–40)	64 (40–95)
E2	0.1	45 (35–50)	82 (45–95)
E3	0.1	77 (45–95)	133 (60–150)
	18.25	81 (80–100)	163 (150–480)
E4	3	175 (130–210)	375 (220–410)
	15.25	114 (100–190)	252 (190–420)
	19.8	100 (100–100)	190 (190–190)
	198	98 (95–100)	187 (180–190)
E5	0.1	117 (55–130)	212 (80–250)
	15.25	144 (130–310)	278 (240–725)
E6	0.1	148 (65–170)	263 (95–310)
	3	215 (190–260)	463 (330–625)
	15.25	191 (170–410)	386 (310–825)
E7	3	355 (260–500)	614 (490–750)
	18.25	439 (330–550)	628 (575–675)
E8	0.1	272 (260–280)	482 (370–525)
	45.75	401 (280–950)	770 (500–1,775)
E9	0.1	368 (320–400)	610 (420–800)
E10	0.1	442 (230–525)	715 (330–1,025)
E11	18.5	765 (625–1,000)	1,342 (950–2,025)
	45.75	811 (525–2,025)	1,498 (850–3,525)
E12	0.1	550 (400–700)	881 (500–1,275)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

Table 3.7-69: SEL-Based Ranges to PTS, TTS, and Behavioral Reaction for Phocids

Range to Effects for Explosives: Phocids[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E1	0.1	1	45 (40–65)	210 (100–290)	312 (130–430)
		25	190 (95–260)	798 (280–1,275)	1,050 (360–2,275)
E2	0.1	1	58 (45–75)	258 (110–360)	383 (150–550)
		10	157 (85–240)	672 (240–1,275)	934 (310–1,525)
E3	0.1	1	96 (60–120)	419 (160–625)	607 (220–900)
		12	277 (120–390)	1,040 (370–2,025)	1,509 (525–6,275)
	18.25	1	118 (110–130)	621 (500–1,275)	948 (700–2,025)
		12	406 (330–875)	1,756 (1,025–4,775)	3,302 (1,025–6,275)
E4	3	2	405 (300–430)	1,761 (1,025–2,775)	2,179 (1,025–3,275)
	15.25	2	265 (220–430)	1,225 (975–1,775)	1,870 (1,025–3,275)
	19.8	2	220 (220–220)	991 (950–1,025)	1,417 (1,275–1,525)
	198	2	150 (150–150)	973 (925–1,025)	2,636 (2,025–3,525)
E5	0.1	25	569 (200–850)	2,104 (725–9,275)	2,895 (825–11,025)
	15.25	25	920 (825–1,525)	5,250 (2,025–10,275)	7,336 (2,275–16,025)
E6	0.1	1	182 (90–250)	767 (270–1,275)	1,011 (370–1,775)
	3	1	392 (340–440)	1,567 (1,275–1,775)	2,192 (2,025–2,275)
	15.25	1	288 (250–600)	1,302 (1,025–3,275)	2,169 (1,275–5,775)
E7	3	1	538 (450–625)	2,109 (1,775–2,275)	2,859 (2,775–3,275)
	18.25	1	530 (460–750)	2,617 (1,025–4,525)	3,692 (1,525–5,275)
E8	0.1	1	311 (290–330)	1,154 (625–1,275)	1,548 (725–2,275)
	45.75	1	488 (380–975)	2,273 (1,275–5,275)	3,181 (1,525–8,025)
E9	0.1	1	416 (350–470)	1,443 (675–2,025)	1,911 (800–3,525)
E10	0.1	1	507 (340–675)	1,734 (725–3,525)	2,412 (800–5,025)

Table 3.7-69: SEL-Based Ranges to PTS, TTS, and Behavioral Reaction for Phocids (continued)

Range to Effects for Explosives: Phocids[1]					
Bin	Source Depth (m)	Cluster Size	PTS	TTS	Behavioral
E11	18.5	1	1,029 (775–1,275)	5,044 (2,025–8,775)	6,603 (2,525–14,525)
	45.75	1	881 (700–2,275)	3,726 (2,025–8,775)	5,082 (2,025–13,775)
E12	0.1	1	631 (450–750)	1,927 (800–4,025)	2,514 (925–5,525)
	0.1	3	971 (550–1,025)	2,668 (1,025–6,275)	3,541 (1,775–9,775)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.

Table 3.7-70: Peak Pressure Based Ranges to Onset PTS ad Onset TTS for Phocids

Range to Effects for Explosives: Phocids[1]			
Bin	**Source Depth (m)**	**PTS**	**TTS**
E1	0.1	144 (60–160)	258 (95–300)
E2	0.1	180 (70–220)	323 (110–370)
E3	0.1	303 (100–350)	533 (150–675)
	18.25	373 (270–950)	697 (470–1,775)
E4	3	548 (470–700)	1,230 (675–2,525)
	15.25	567 (460–750)	927 (675–1,525)
	19.8	459 (440–480)	823 (800–900)
	198	431 (420–440)	864 (800–1,000)
E5	0.1	469 (140–600)	815 (190–6,025)
	15.25	604 (550–900)	1,061 (725–1,775)
E6	0.1	582 (160–775)	910 (230–6,025)
	3	888 (750–1,025)	1,484 (1,025–1,775)
	15.25	822 (650–1,525)	1,426 (875–2,775)
E7	3	1,109 (1,025–1,525)	2,109 (1,775–2,525)
	18.25	1,482 (1,025–2,025)	2,766 (1,775–4,775)
E8	0.1	987 (500–1,275)	1,472 (625–2,025)
	45.75	1,695 (800–4,525)	2,896 (1,275–8,025)
E9	0.1	1,207 (550–1,525)	1,790 (700–3,025)
E10	0.1	1,407 (450–3,275)	2,043 (775–5,275)
E11	18.5	3,311 (1,775–7,025)	5,848 (2,275–12,525)
	45.75	3,053 (1,525–8,275)	4,178 (1,775–11,275)
E12	0.1	1,580 (675–2,525)	2,228 (825–3,775)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.

3.7.3.2.2.3 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), Table 2.6-2, and Section 3.0.3.3.2 (Explosive Stressors), training activities under Alternative 1 would use underwater detonations and explosive munitions. Within Alternative 1, most training activities that use explosives reoccur on an annual basis, with some variability year-to-year. Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore and often in areas designated for explosive use.
- As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.6-3 through Table 2.6-5, and Section 3.0.3.3.2 (Explosive Stressors), testing activities under Alternative 1 would use underwater detonations and explosive munitions. Within Alternative 1, most testing activities that use explosives reoccur on an annual basis. Testing activities using explosions do not normally occur within 3 NM of shore.
- As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.6-2, and Section 3.0.3.3.2 (Explosive Stressors), training activities under Alternative 2 would use underwater detonations and explosive munitions. Within Alternative 2, most training activities that use explosives reoccur on an annual basis, with the same number of exercises planned each year. Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore and often in areas designated for explosive use.
- As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.6-3 through Table 2.6-5, and Section 3.0.3.3.2 (Explosive Stressors), testing activities under Alternative 2 would use underwater detonations and explosive munitions. Within Alternative 2, most testing activities that use explosives reoccur on an annual basis. Testing activities using explosions do not normally occur within 3 NM of shore.

Presentation of Estimated Impacts from the Quantitative Analysis

The results of the analysis of potential impacts on marine mammals from explosives (see above Section 3.7.3.2.2.1, Methods for Analyzing Impacts from Sonars and Other Transducers) 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 (Acoustic Impact Tables). Additionally, estimated numbers of potential impacts from the quantitative analysis for each species are presented below (e.g., Figure 3.7-96). The most likely regions and activity categories from which the impacts could occur are displayed in the impact graphics for each species. There is a potential for impacts on 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 impact graphics below. All (i.e., grand total) estimated impacts are also included, regardless of region or category.

Regions within the HSTT Study Area include (see Study Area maps Chapter 2) the Hawaii OPAREA, the Temporary Hawaii OPAREA, the SOCAL Defined Training Areas, the Western SOCAL OPAREA, and the Transit Lane. The SOCAL portion of the HSTT Study Area encompasses the SOCAL Defined Training Areas that are located within approximately 200 NM of the coast and the Western SOCAL OPAREA, which extends westward beyond 200 NM. Similarly, the Hawaii Range Complex portion of the HSTT Study Area is divided into the Hawaii OPAREA that is located around the main Hawaiian Islands within about 200 NM and the Temporary Hawaii OPAREA that extends to the northwest beyond about 200 NM.

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 3.0.3.3.2 (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 3.7.2.1.4, 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 3.7.3.2.2.2(Impact Ranges for Explosives).

Mysticetes that do experience threshold shift from explosive sounds may have reduced ability to detect biologically important sounds (e.g., social vocalizations) until their hearing recovers. Recovery from threshold shift 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 3.7.3.1.1.4 (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 explosion, 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 on 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 3.7.3.2.1.3 (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.

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. The quantitative analysis, using the maximum number of explosives per year under Alternative 1, estimates TTS and PTS (see Figure 3.7-96 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-71).

For mysticetes, 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area in July through October. Navy training activities that use explosives could occur year round within the Study Area although are concentrated on Navy ranges; however, these four feeding areas make up a very small portion of the Southern California Range Complex. As discussed above, blue whale reactions to explosives are most likely TTS, although these impacts are unlikely to occur to whales within the identified areas due to little overlap with explosive activities. Therefore, significant impacts on blue whale feeding behaviors from training with explosives are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

Pursuant to the MMPA, the use of explosives 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 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 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 TTS (see Figure 3.7-96 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-71).

For mysticetes, 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area in July through October. Navy testing activities that use explosives could occur year round within the Study Area although are concentrated on Navy ranges; however, these four feeding areas make up a very small portion of the Southern California Range Complex. As discussed above, blue whale reactions to explosives are most likely TTS, although these impacts are unlikely to occur to whales within the identified areas due to little overlap with explosive activities. Therefore, significant impacts on blue whale feeding behaviors from testing with explosives are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015).

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.

Figure 3.7-96: Blue Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses or injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-71: 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

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Eastern North Pacific	100%	98%
Central North Pacific	0%	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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 explosives during training activities as described under Alternative 2 may affect ESA-listed blue whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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.

Bryde's Whales

Impacts from Explosives Under Alternative 1 for Training Activities

Bryde's 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 TTS (see Figure 3.7-97 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-71)

As described for other mysticetes 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 will 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 Bryde's 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 Explosives Under Alternative 1 for Testing Activities

Bryde's whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the quantitative analysis estimates that no Bryde's whales would be impacted. Long-term consequences for individuals, 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 not result in the unintentional taking of Bryde's whales incidental to those activities.

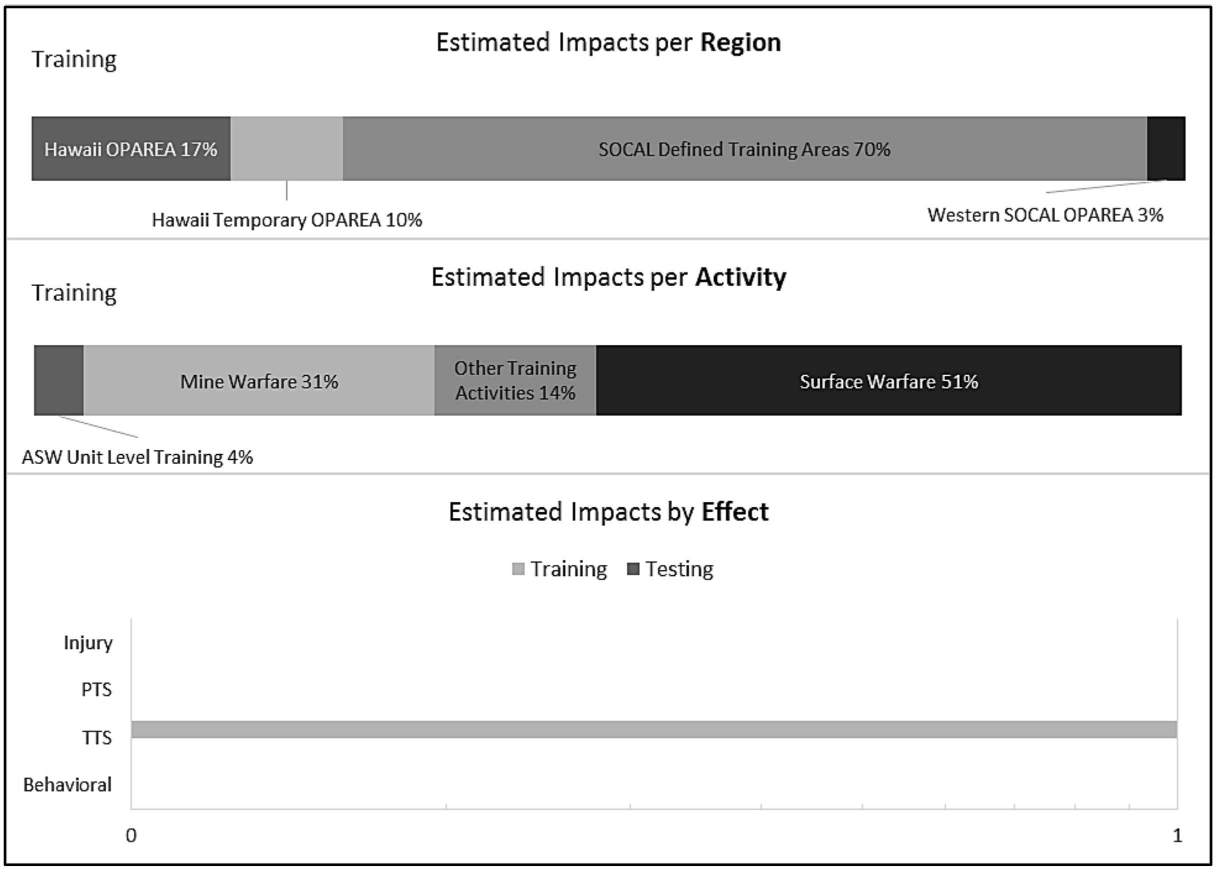


Figure 3.7-97: Bryde's Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for testing activities. No behavioral responses, PTS, or injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-72: Estimated Impacts on Individual Bryde's Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	27%	0%
Eastern Tropical Pacific	73%	0%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of Bryde's whales incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

Bryde's whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the quantitative analysis estimates that no Bryde's whales would be impacted. Long-term consequences for individuals, the species, or stocks would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will not result in the unintentional taking of Bryde's whales incidental to those activities.

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. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates TTS (see Figure 3.7-98 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-73).

As described for other mysticetes 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 will 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 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 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 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 and PTS (see Figure 3.7-98 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-73).

As described for other mysticetes 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 will 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 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.

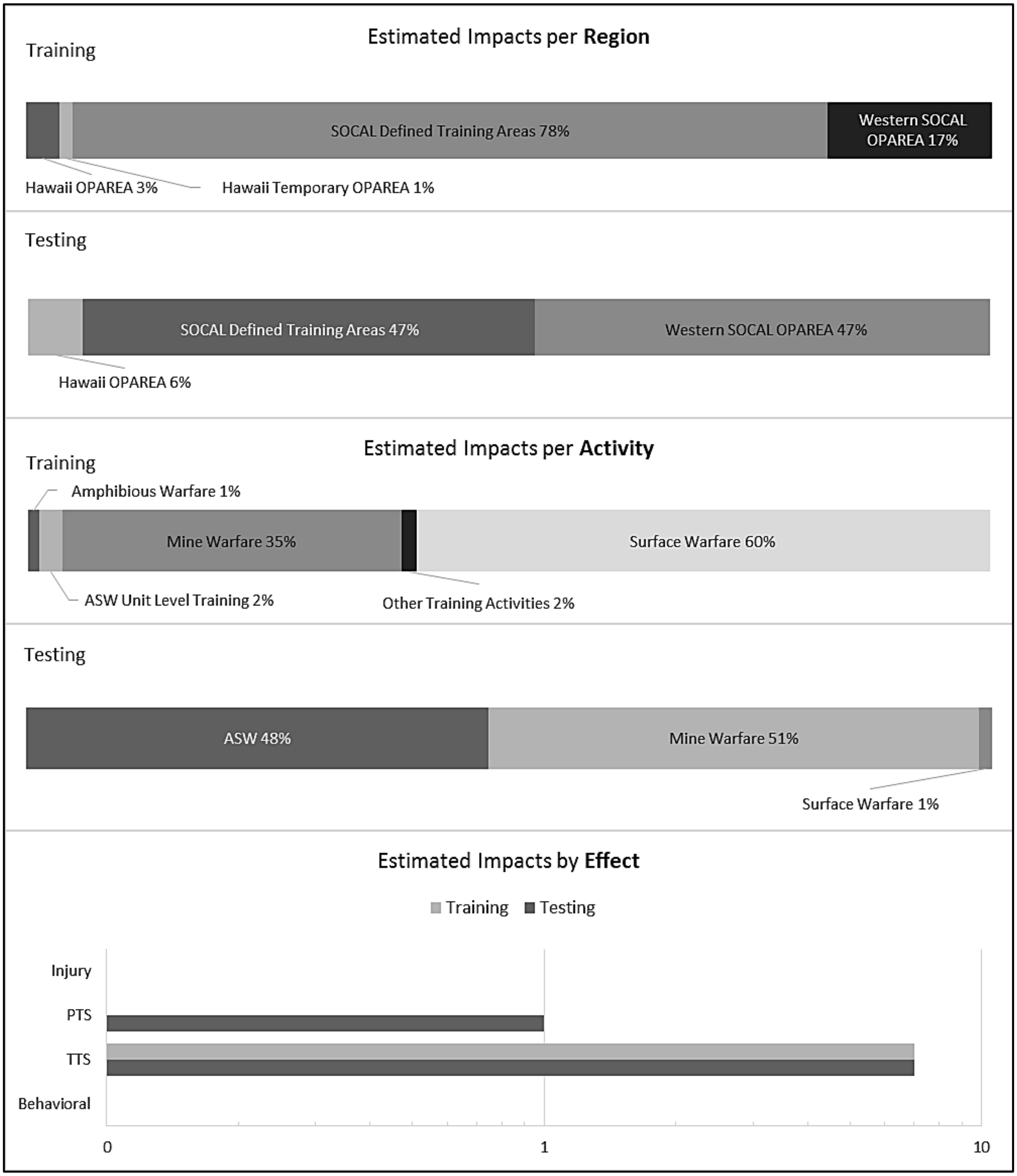


Figure 3.7-98: Fin Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses or injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-73: 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

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	95%	94%
Hawaiian	5%	6%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 explosives during training activities as described under Alternative 2 may affect ESA-listed fin whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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.

Gray Whales

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 for 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.

Impacts from Explosives Under Alternative 1 for Training Activities

Gray 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 TTS and PTS (see Figure 3.7-99 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the Eastern North Pacific stock.

As described for other mysticetes 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A migration corridor for gray whales identified by Calambokidis et al. (2015) overlaps the Southern California Range Complex within the Study Area. Navy training activities that use explosives could occur year round within the Southern California Range Complex; however, within the Southern California Range Complex training with explosives typically occurs only within localized designated areas, which are all small compared to the size of the migration corridor that spreads across the entire southern California Bight (Calambokidis et al. 2015). Gray whales in the identified feeding area could be exposed to limited sound or energy from explosives; therefore, impacts on migration might include a slight shift in migration path or slowing in travel speed as has been observed for migrating gray whales when seismic noise was in their path (e.g., Malme 1984). This would be a low severity behavioral response and would not affect their overall migration behavior within the designated migration corridor.

Pursuant to the MMPA, the use of explosives 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 explosives during training activities as described under Alternative 1 would not affect ESA-listed gray whales.

Impacts from Explosives Under Alternative 1 for Testing Activities

Gray 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 TTS and PTS (see Figure 3.7-99 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the Eastern North Pacific stock.

As described for other mysticetes 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A migration corridor for gray whales identified by Calambokidis et al. (2015) overlaps the Southern California Range Complex within the Study Area. Navy testing activities that use explosives could occur year round within the Southern California Range Complex; however, within the Southern California Range Complex testing with explosives typically occurs only within localized designated areas, which are all small compared to the size of the migration corridor that spreads across the entire southern California Bight (Calambokidis et al. 2015). Gray whales in the identified migration area could be exposed to limited sound or energy from explosives; therefore, impacts on migration might include a slight shift in migration path or slowing in travel speed as has been observed for migrating gray whales when seismic noise was in their path (e.g., Malme 1984). This would be a low severity behavioral response and would not affect their overall migration behavior within the designated migration corridor.

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 would not affect ESA-listed gray whales.

Figure 3.7-99: Gray Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses or injuries (non-auditory) are estimated for this species. 100 percent Eastern North Pacific Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 explosives during training activities as described under Alternative 2 would not affect ESA-listed gray whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 explosives during testing activities as described under Alternative 2 would not affect ESA-listed gray whales.

Humpback Whales

Impacts have been modeled for the Hawaiian population of humpback whales, which are not Endangered Species Act-Listed, and for the Mexican and Central American populations of humpback whales, which are Endangered Species Act-Listed.

Impacts from Explosives Under Alternative 1 for Training Activities

Humpback 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 TTS and PTS (see Figure 3.7-100 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-74).

As described for other mysticetes 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

The breeding area for humpback whales identified by Baird et al. (2015) overlaps the Hawaii Range Complex within the Study Area. Navy training activities that use explosives could occur year round within the Hawaii Range Complex; however, within the Hawaii Range Complex training with explosives typically occurs only in offshore waters except for some activity near Honolulu. In either case, the training occurs outside the humpback whale breeding area identified by Baird et al. (2015). Humpback whales within the identified breeding area would not be directly exposed to sound or energy from explosions; therefore, impacts on breeding behaviors would not be anticipated within the identified humpback whale breeding area from training with explosives.

Pursuant to the MMPA, the use of explosives 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 explosives 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.

Impacts from Explosives Under Alternative 1 for Testing Activities

Humpback 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 TTS and PTS (see Figure 3.7-100 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-74).

As described for other mysticetes 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

The breeding area for humpback whales identified by Baird et al. (2015) overlaps the Hawaii Range Complex within the Study Area. Navy testing activities that use explosives could occur year round within the Hawaii Range Complex; however, within the Hawaii Range Complex testing with explosives typically occurs only in offshore waters except for some activity near Honolulu; in either case, the testing occurs outside the humpback whale breeding area identified by Baird et al. (2015). Humpback whales within the identified breeding area would not be directly exposed to sound or energy; therefore, impacts on breeding behaviors would not be anticipated within the identified humpback whale breeding area from testing with explosives.

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. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

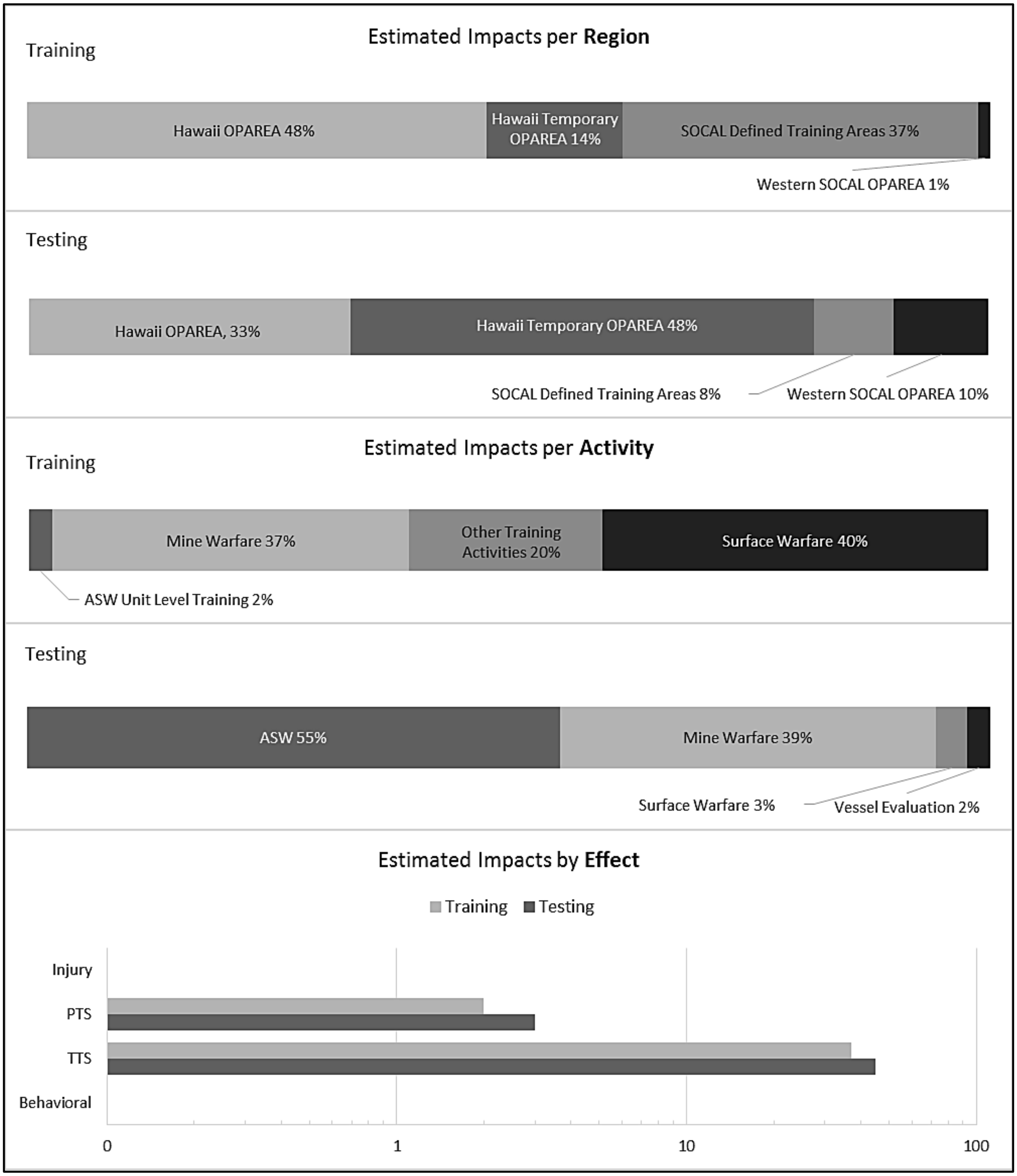


Figure 3.7-100: Humpback Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses or injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-74: 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

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Central America DPS (California, Oregon, & Washington)	4%	10%
Mexico DPS (California, Oregon, & Washington)	35%	8%
Hawaii DPS (Central North Pacific)	62%	82%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 explosives during training activities as described under Alternative 2 may affect ESA-listed humpback whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 explosives during training activities as described under Alternative 2 may affect ESA-listed humpback 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 TTS and PTS (see Figure 3.7-101 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-75).

As described for other mysticetes 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 will 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 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 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 TTS and PTS (see Figure 3.7-101 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-75).

As described for other mysticetes 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 will 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 minke whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

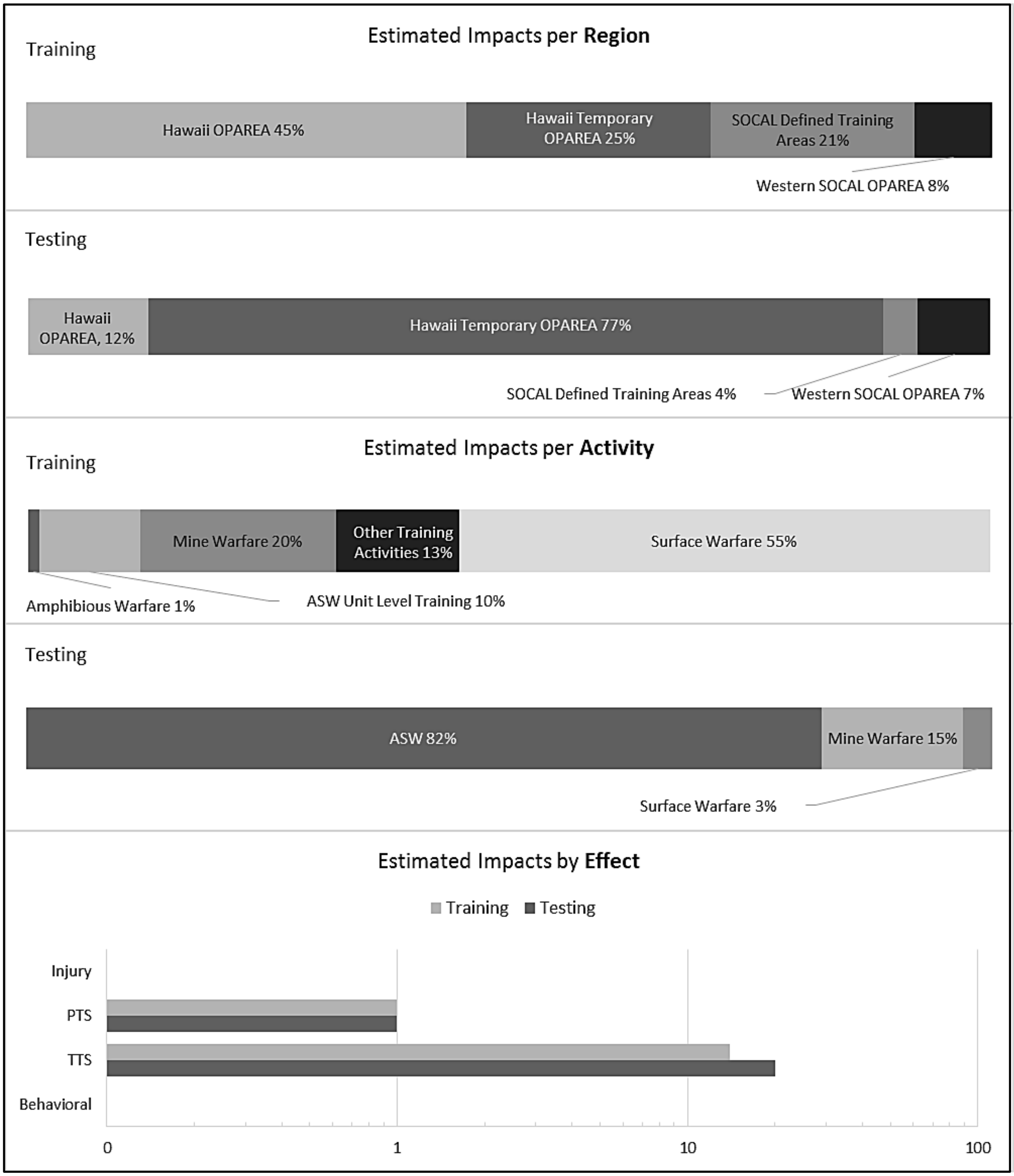


Figure 3.7-101: Minke Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses or injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-75: 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

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	29%	11%
Hawaiian	71%	89%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of minke whales incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of minke whales incidental to those activities.

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. The quantitative analysis, using the maximum number of explosions per year under Alternative 1, estimates TTS (see Figure 3.7-102 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-76).

As described for other mysticetes 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 will 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 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 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 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 (see Figure 3.7-102 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-76).

As described for other mysticetes 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 will 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 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 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.

Figure 3.7-102: Sei Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses, PTS, or injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-76: 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

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	29%	55%
Eastern North Pacific	71%	45%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 explosives during training activities as described under Alternative 2 may affect ESA-listed sei whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

Potential annual impacts on this 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. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for this species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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.

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 3.7.2.1.4, 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 3.7.3.2.2.2 (Impact Ranges for Explosives) under mid-frequency cetaceans for most species, and under high-frequency cetaceans for Kogia whales and Dall's porpoises.

Injuries (non-auditory) 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 threshold shift from explosive sounds may have reduced ability to detect biologically important sounds (e.g., social vocalizations) until their hearing recovers. Recovery from a hearing threshold shift begins almost immediately after the noise exposure ceases. A threshold shift 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 threshold shift. 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 threshold shift 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 3.7.3.1.1.4 (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 3.7.3.1.1.5, 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 3.7.3.2.1.3, 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.

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 behavioral reactions and TTS (see Figure 3.7-103 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-77).

For odontocetes, 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 will 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 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 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 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 (see Figure 3.7-103 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-77).

For odontocetes, 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 will 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 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 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.

Figure 3.7-103: Sperm Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No PTS or injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-77: Estimated Impacts on Individual Sperm Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	86%	80%
Hawaiian	14%	20%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 explosives during training activities as described under Alternative 2 may affect ESA-listed sperm whales.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 explosives during testing activities as described under Alternative 2 may affect ESA-listed sperm whales.

Kogia Whales

Kogia whales include two species that are often difficult to distinguish from one another: dwarf sperm whales and pygmy sperm whales. Impacts on the California, Oregon and Washington stock of Kogia whales are not broken out by species.

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 behavioral reactions, TTS, and PTS (see Figure 3.7-104 through Figure 3.7-106, and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts on pygmy and dwarf sperm whales apply only to the Hawaiian stock. Estimated impacts on Kogia whales apply only to the California, Oregon, and Washington stock.

For odontocetes, 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for dwarf sperm whales identified by Baird et al. (2015) is within the Hawaii Range Complex. This area occurs off the West Coast of the Big Island of Hawaii. The Navy does not generally train with explosives in this area. Dwarf sperm whales in the identified small and resident population areas identified by Baird et al. (2015) would not be exposed directly to sound or energy from explosives; therefore, impacts would not be anticipated within the identified dwarf sperm whale small and resident population area from training with explosives.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of 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 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 behavioral reactions, TTS, and PTS (see Figure 3.7-104 through Figure 3.7-106, and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts on pygmy and dwarf sperm whales apply only to the Hawaiian stock. Estimated impacts on Kogia whales apply only to the California, Oregon, and Washington stock.

For odontocetes, 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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for dwarf sperm whales identified by Baird et al. (2015) is within the Hawaii Range Complex. This area occurs off the West Coast of the Big Island of Hawaii. The Navy does not generally conduct explosive testing in this area. Dwarf sperm whales in the identified small and resident population areas identified by Baird et al. (2015) would not be exposed directly to sound or energy from explosives; therefore, impacts would not be anticipated within the identified dwarf sperm whale small and resident population area from testing with explosives.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of 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.

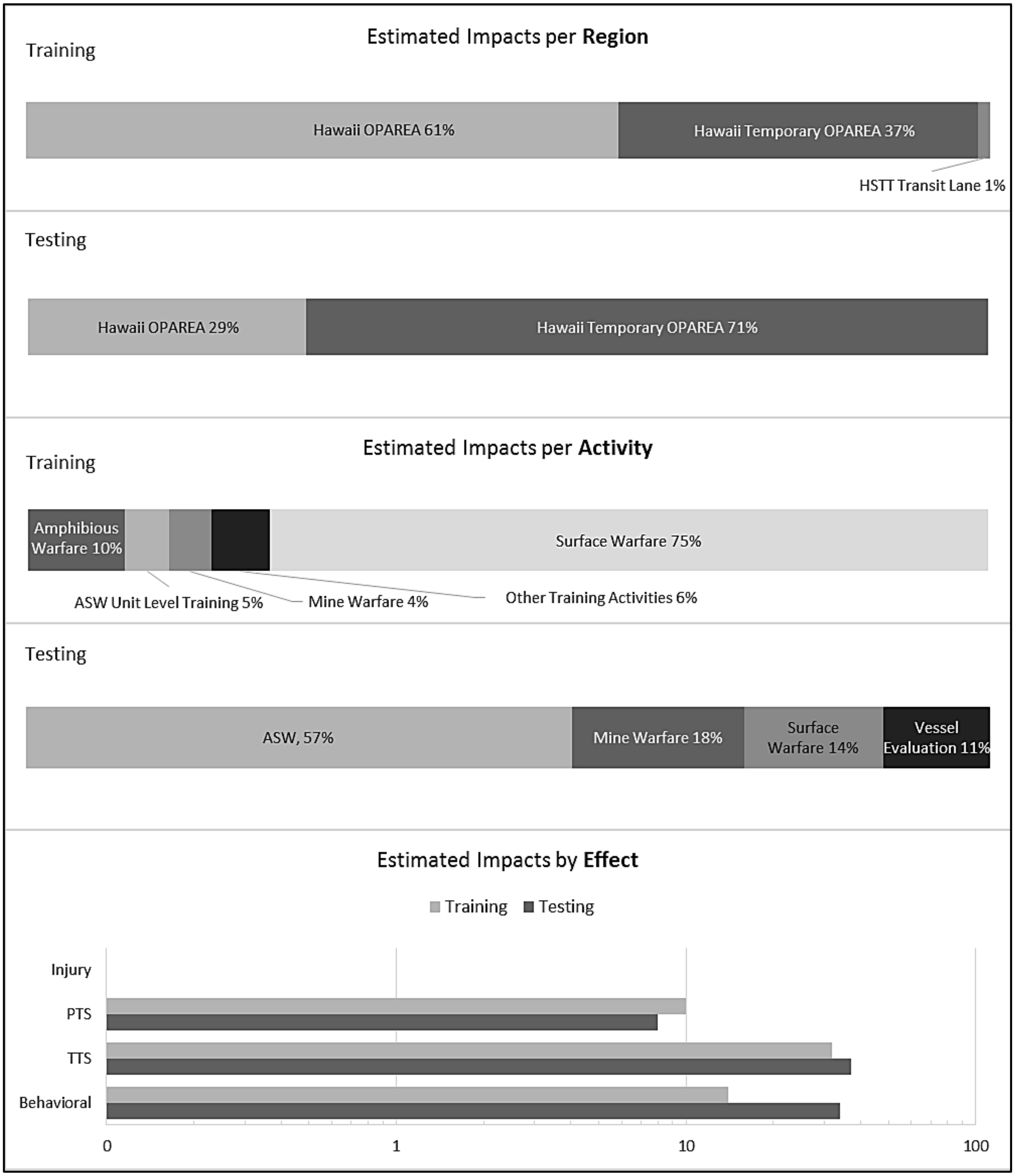


Figure 3.7-104: Pygmy Sperm Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

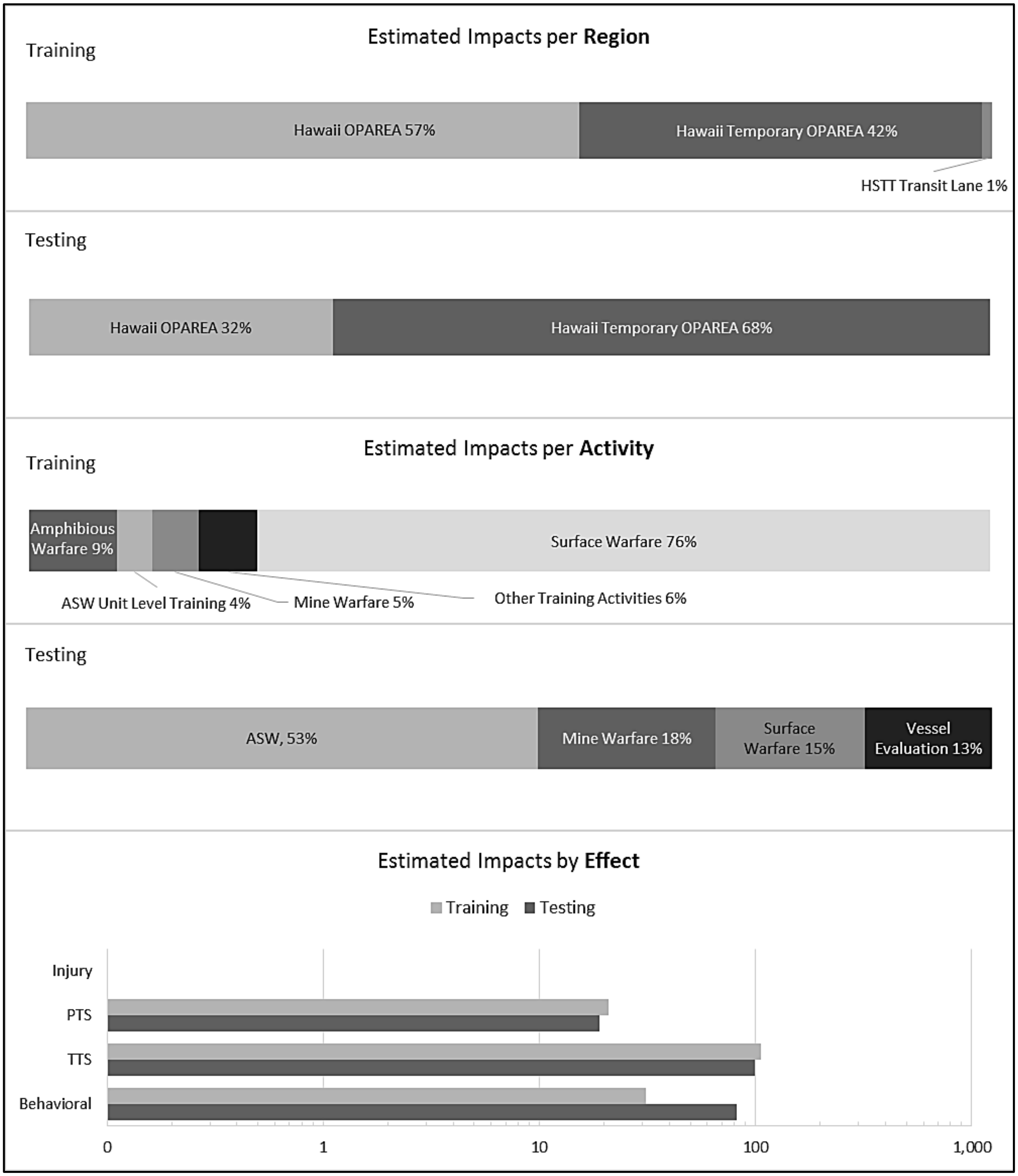


Figure 3.7-105: Dwarf Sperm Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

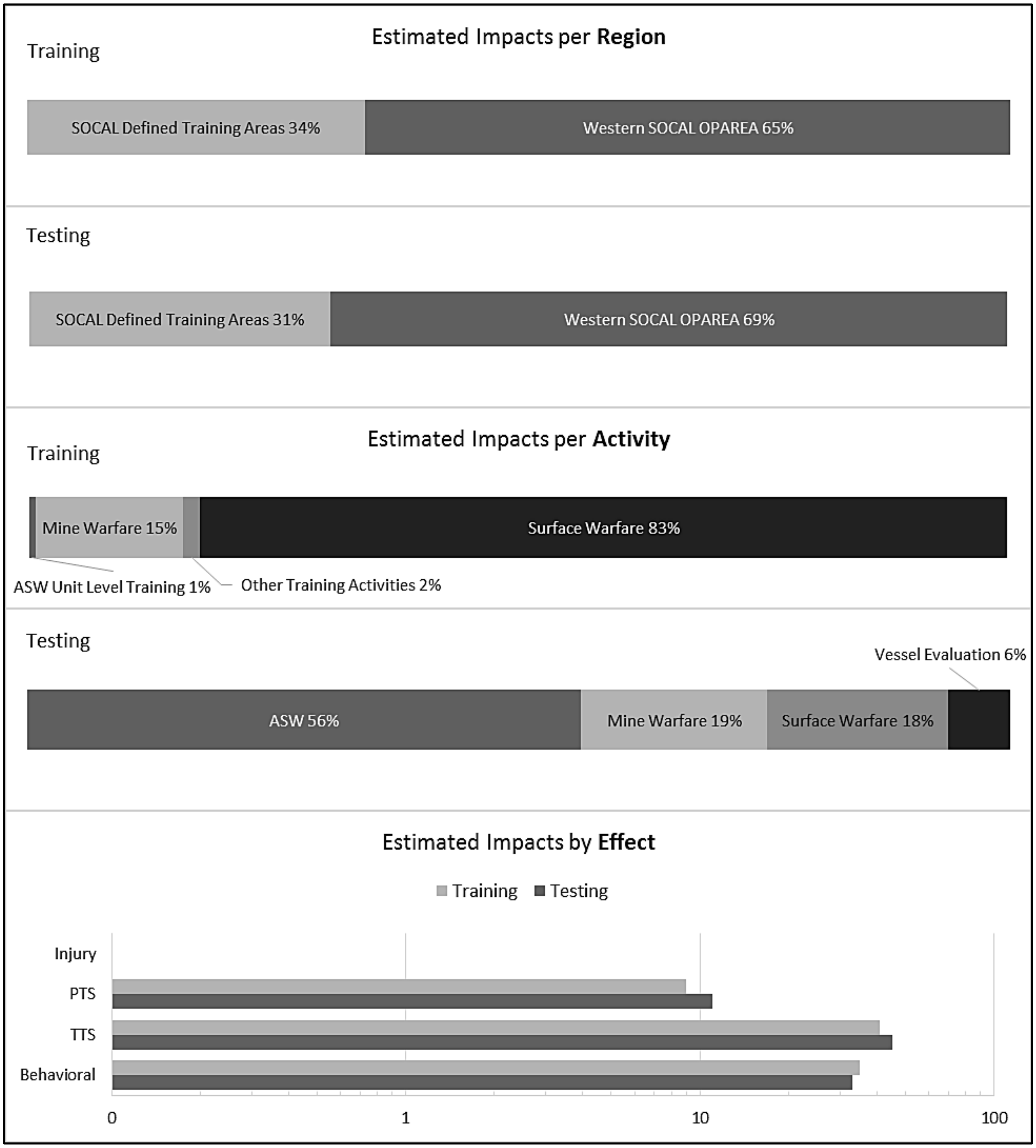


Figure 3.7-106: Kogia Whales Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for these species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of dwarf and pygmy sperm whales (Hawaiian stocks) and Kogia whales (California, Oregon, Washington stock) incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of dwarf and pygmy sperm whales (Hawaiian stocks) and Kogia whales (California, Oregon, Washington stock) incidental to those activities.

Beaked Whales

Beaked whales within the HSTT study area include: Baird’s beaked whale, Blainville’s beaked whale, Cuvier’s beaked whale, Hubb's beaked whale, Ginkgo-toothed beaked whale, Longman’s beaked whale, Perrin’s beaked whale, Stejneger’s beaked whale, and the Pygmy beaked whale. Impacts on 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 small beaked whale guild (Mesoplodon spp.).

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 behavioral and TTS for the small beaked whale guild (Mesoplodon spp.) (see Figure 3.7-107 and Table 3.7-78 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. No impacts are estimated for Baird's beaked whale, Blainville's beaked whale, Cuvier's beaked whale, or Longman's beaked whale. Estimated impacts for the small beaked whale guild (Mesoplodon spp.) only apply to the California, Oregon, and Washington stock.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for Blainville's beaked whales identified by Baird et al. (2015) occurs in the Hawaii Range Complex off the West Coast of the Big Island of Hawaii. A small and resident population area for Cuvier's beaked whales identified by Baird et al. (2015) occurs in the Hawaii Range Complex around the Big Island of Hawaii. The Navy does not generally train with explosives in either of these areas. Blainville's and Cuvier's beaked whales in the identified small and resident population areas identified by Baird et al. (2015) would not be exposed directly to sound or energy from explosions; therefore, impacts would not be anticipated within the identified Blainville's and Cuvier's beaked whale small and resident population areas from training with explosives.

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of Hubb's, ginkgo-toothed, Perrin's, Stejneger's, and pygmy beaked whales 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 Explosives Under Alternative 1 for Testing Activities</u>

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 TTS for Longman's beaked whales and behavioral and TTS for the small beaked whales guild (Mesoplodon spp.) (see Figure 3.7-107 and Table 3.7-78 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. No impacts are estimated for Baird's or Blainville's beaked whales. Estimated impacts on Longman's beaked whales apply only to the Hawaiian stock. Estimated impacts on the small beaked whale guild (*Mesoplodon Spp*.) apply only to the California, Oregon, and Washington stock.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for Blainville's beaked whales identified by Baird et al. (2015) occurs in the Hawaii Range Complex off the West Coast of the Big Island of Hawaii. A small and resident population area for Cuvier's beaked whales identified by Baird et al. (2015) occurs in the Hawaii Range Complex around the Big Island of Hawaii. The Navy does not generally test with explosives in either of these areas. Blainville's and Cuvier's beaked whales in the identified small and resident population areas identified by Baird et al. (2015) would not be exposed directly to sound or energy from explosives;

therefore, impacts would not be anticipated within the identified Blainville's and Cuvier's beaked whale small and resident population areas from testing with explosives.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of Longman's, Hubb's, Cuvier's, ginkgo-toothed, Perrin's, Stejneger's, and Pygmy beaked whales incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

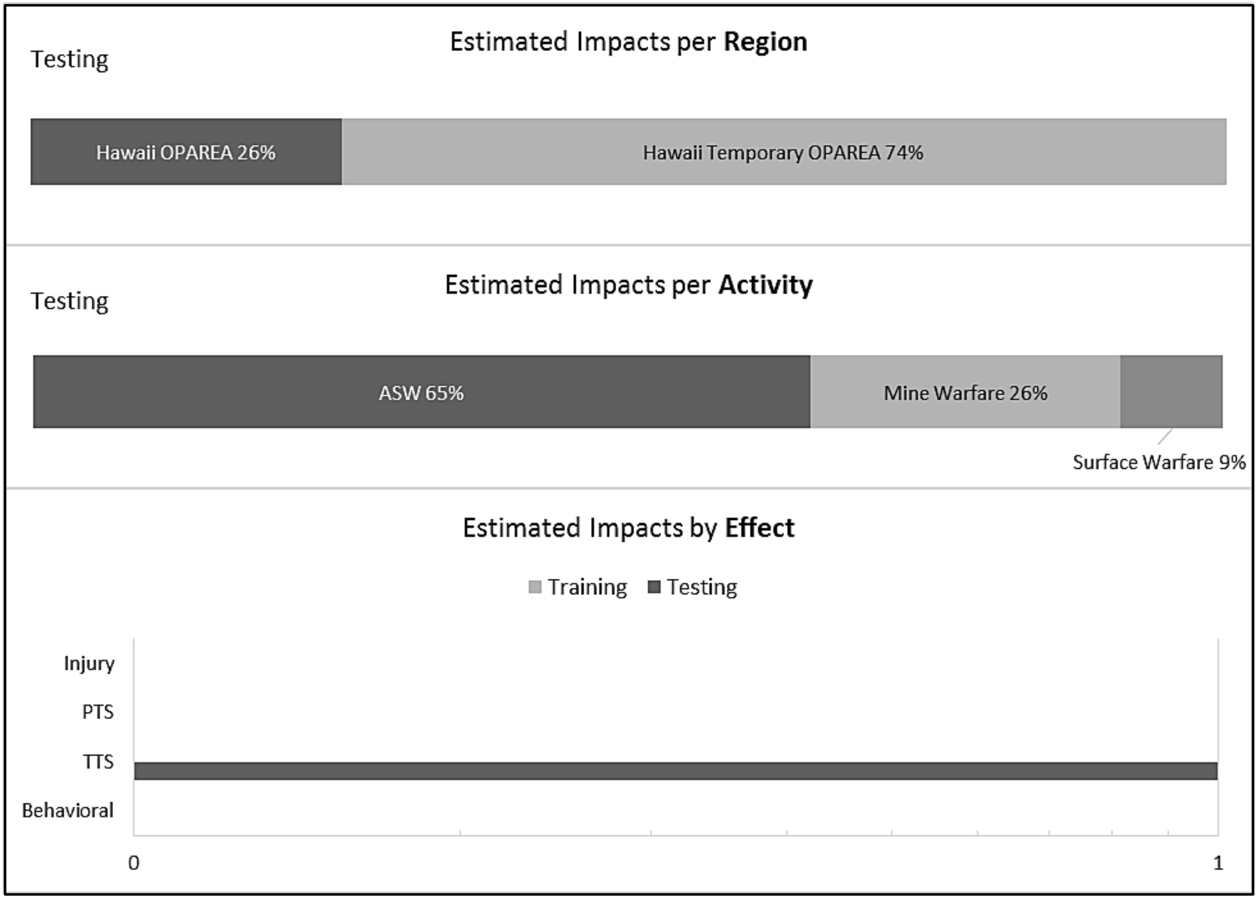


Figure 3.7-107: Longman's Beaked Whale Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for training activities. No behavioral responses, PTS, or injuries (non-auditory) are estimated for this species. 100 percent Hawaiian Stock.
ASW = Anti-Submarine Warfare

Figure 3.7-108: Cuvier's Beaked Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1.

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No PTS or injuries (non-auditory) are estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

Table 3.7-78: Estimated Impacts to Individual Cuvier's Beaked Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1.

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	99%	99%
Hawaiian	1%	1%

Figure 3.7-109: Mesoplodon Spp. (Small Beaked Whale Guild) Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1.

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No PTS or injuries (non-auditory) are estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of Hubb's, ginkgo-toothed, Perrin's, Stejneger's, and pygmy beaked whales incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for these species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of Hubb's, Cuvier's, ginkgo-toothed, Longman's, Perrin's, Stejneger's, and pygmy beaked whales incidental to those activities.

Bottlenose Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

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 behavioral reactions, TTS, and PTS (see Figure 3.7-110 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-79).

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Four small and resident population areas for bottlenose dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within shallow, near-shore waters where the Navy does not typically conduct activities that involve explosives with the exception of mine neutralization activities. However, sound from explosives could still expose animals within the identified bottlenose dolphin small and resident population areas identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, bottlenose dolphin reactions to sounds are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on bottlenose dolphin natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of 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 Explosives Under Alternative 1 for Testing Activities

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 behavioral reactions, TTS, and PTS (see Figure 3.7-110 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-79).

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Four small and resident population areas for bottlenose dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within shallow, near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the identified bottlenose dolphin small and resident population areas identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, bottlenose dolphin reactions to sounds are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on bottlenose dolphin natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

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

Figure 3.7-110: Bottlenose Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-79: Estimated Impacts on Individual Bottlenose Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
4-Island	0%	14%
California Coastal	0%	3%
California, Oregon, and Washington Offshore	55%	78%
Hawaiian Pelagic	2%	3%
Oahu	43%	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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of bottlenose dolphins incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of bottlenose dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

False Killer Whales

False killer whales main Hawaiian Islands Insular stock is Endangered Species Act Listed.

Impacts from Explosives Under Alternative 1 for Training Activities

False 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 TTS (see Figure 3.7-111 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A small and resident population area for false killer whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year round within the Hawaii Range Complex. Much of the high use areas are from the 45 m to 3200 m depth contours and the Navy typically conducts underwater detonations shallower than 45 m and other explosive activities further offshore than the 3200 m contour. Sound from explosives could still expose animals within the high use areas and the false killer whale small and resident population area identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, false killer whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on false killer whale natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of false 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 explosives during training activities as described under Alternative 1 may affect ESA-listed main Hawaiian Islands Insular stock of false killer whales and main Hawaiian Islands Insular false killer whale critical habitat. 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

False killer whales may be exposed to sound or energy from explosions associated with testing activities under Alternative 1 throughout the year, although the quantitative analysis estimates that no false killer whales would be impacted. Long-term consequences for individuals, 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 not result in the unintentional taking of false killer whales incidental to those activities.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 1 would not affect ESA-listed main Hawaiian Islands Insular stock of false killer whales or main Hawaiian Islands Insular false killer whale critical habitat.

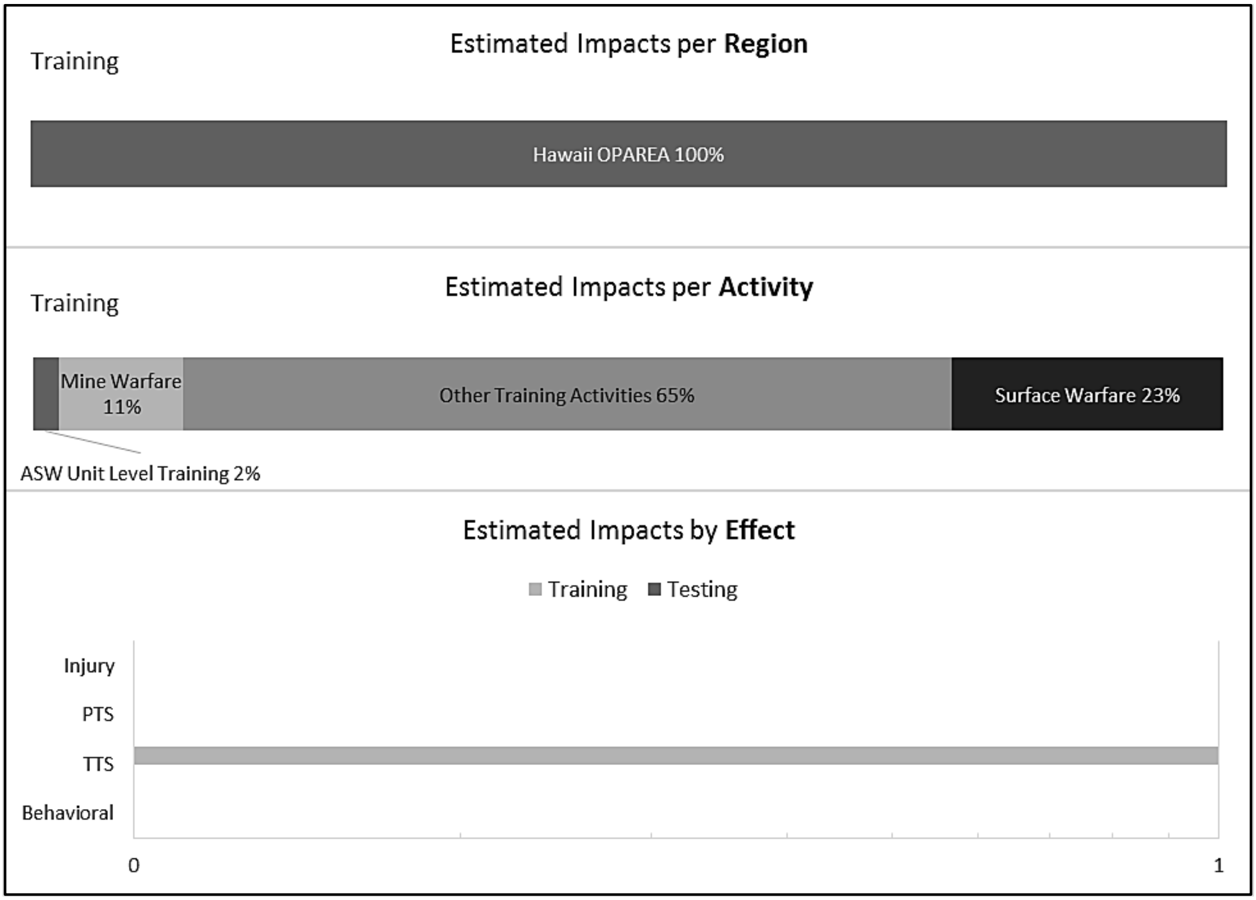


Figure 3.7-111: False Killer Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for testing activities. No behavioral responses, PTS, or injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-80: Estimated Impacts on Individual False Killer Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaii Pelagic	5%	18%
Northwestern Hawaiian Islands	2%	7%
Main Hawaiian Islands Insular	94%	75%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of false killer 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 main Hawaiian Islands Insular stock of false killer whales and main Hawaiian Islands Insular false killer whale critical habitat.

Impacts from Explosives Under Alternative 2 for Testing Activities

False killer whales (main Hawaiian Islands Insular stock is Endangered Species Act Listed) may be exposed to sound or energy from explosions associated with testing activities under Alternative 2 throughout the year, although the quantitative analysis estimates that no false killer whales would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will not result in the unintentional taking of false killer whales incidental to those activities.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 would not affect ESA-listed main Hawaiian Islands Insular stock of false killer whales or main Hawaiian Islands Insular false killer whale critical habitat.

Fraser's Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

Fraser's dolphin 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 reaction, TTS, and PTS (see Figure 3.7-112 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts only apply to the Hawaiian Stock.

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 will 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 Fraser's 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 Explosives Under Alternative 1 for Testing Activities

Fraser'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 behavioral reactions, TTS, and PTS (see Figure 3.7-112) and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the Hawaiian Stock.

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 will 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 testing activities as described under Alternative 1 will result in the unintentional taking of Fraser's dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

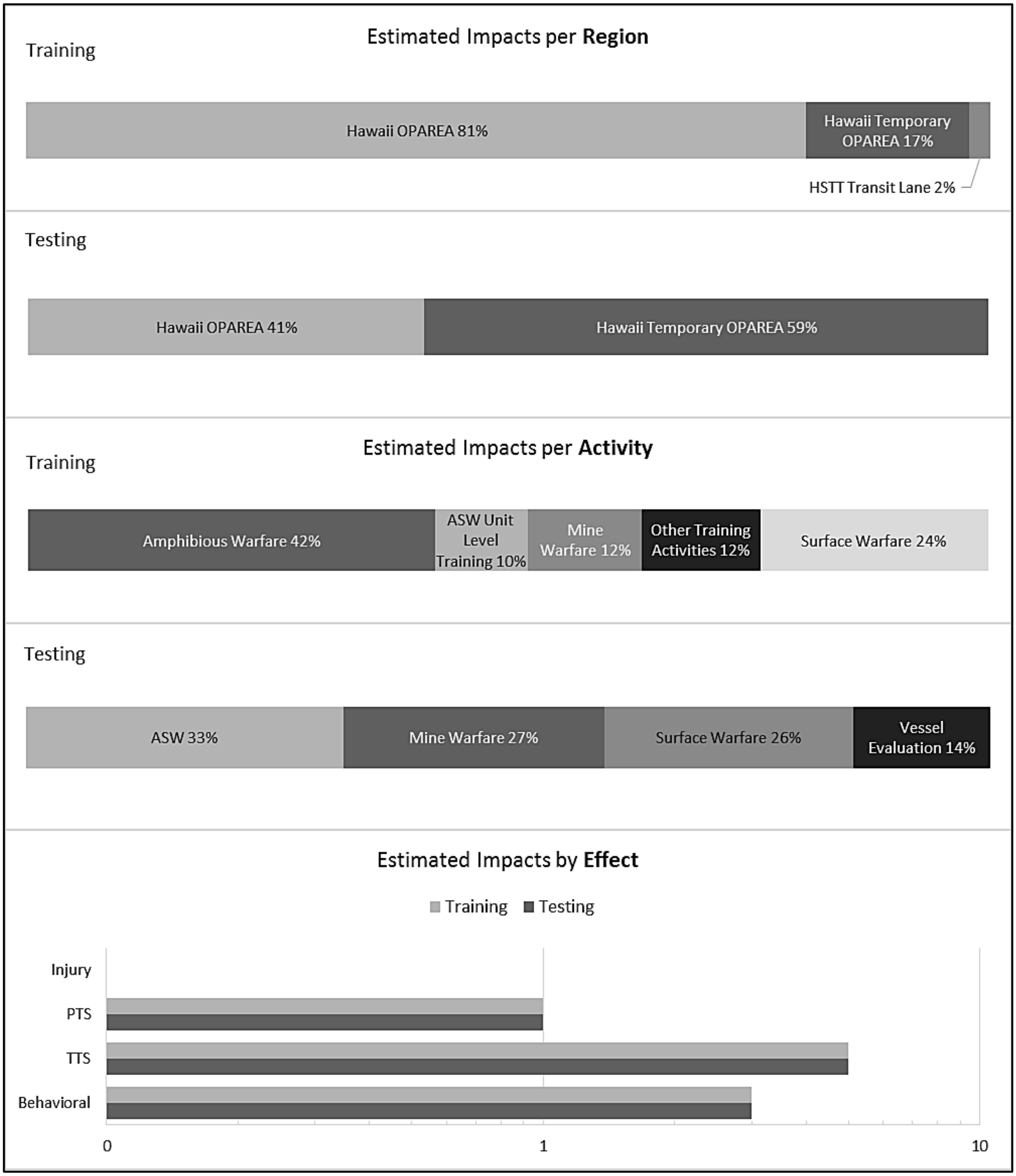


Figure 3.7-112: Fraser's Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of Fraser's 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 identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for this species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of Fraser's dolphins incidental to those activities.

Killer Whales

Killer whales may be exposed to sound or energy from explosions associated with training or testing activities throughout the year, although the quantitative analysis estimates that no killer whales would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training or testing activities as described under Alternative 1 or 2 will not result in the unintentional taking of killer whales incidental to those activities.

Long-Beaked Common Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

Long-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 behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 3.7-113 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California Stock.

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. Non-auditory injury includes low severity injuries; following recovery, any long-term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even if an injury created long-term consequences for that individual.

Considering these factors and the mitigation measures that will 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 long-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 Explosives Under Alternative 1 for Testing Activities

Long-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 behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 3.7-113 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California Stock.

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. Non-auditory injury includes low severity injuries; following recovery, any long-term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even if an injury created long-term consequences for that individual or lead to mortality. Considering these factors and the mitigation measures that will 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 long-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.

Figure 3.7-113: Long-Beaked Common Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. 100 percent California Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of long-beaked common dolphins incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of long-beaked common dolphins incidental to those activities.

Melon-Headed Whales

Impacts from Explosives Under Alternative 1 for Training Activities

Melon-headed 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 behavioral reactions and TTS (see Figure 3.7-114 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the Hawaiian Islands Stock.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A small and resident population area for melon-headed whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the melon-headed whale small and resident population area identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, melon-headed whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on melon-headed whale natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of melon-headed 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 Explosives Under Alternative 1 for Testing Activities

Melon-headed whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the quantitative analysis estimates that no melon-headed whales would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

A small and resident population area for melon-headed whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosions could still expose animals within the melon-headed whale small and resident population area identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, melon-headed whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on melon-headed whale natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will not result in the unintentional taking of melon-headed whales incidental to those activities.

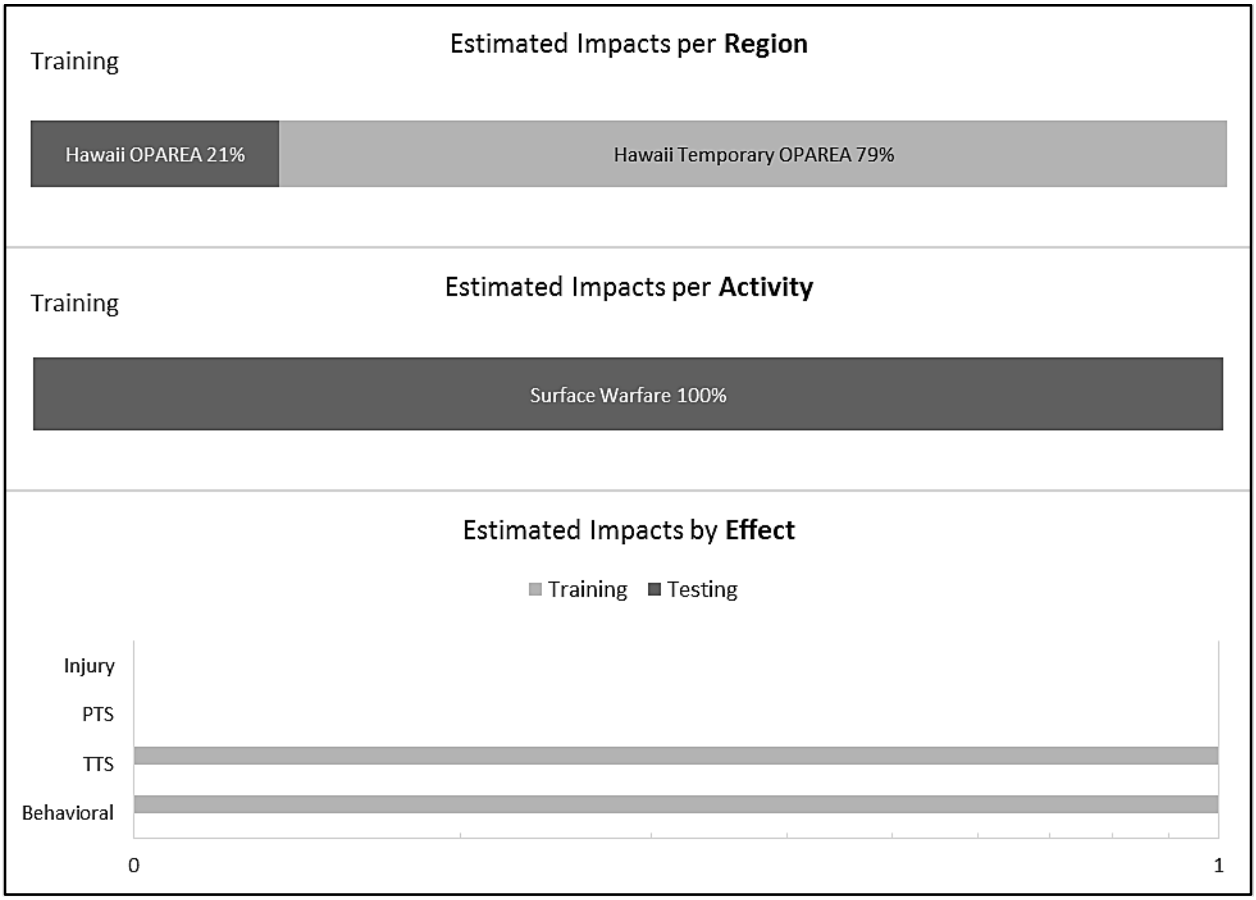


Figure 3.7-114: Melon-Headed Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for testing activities. No PTS or injuries (non-auditory) are estimated for this species. 100 percent Hawaiian Islands Stock. ASW = Anti-Submarine Warfare

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts on this species 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 under Alternative 2 for training does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for this species from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of melon-headed whales incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

Melon-headed whales may be exposed to sound or energy from explosions associated with testing activities under Alternative 2 throughout the year, although the quantitative analysis estimates that no melon-headed whale would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will not result in the unintentional taking of melon-headed whales incidental to those activities.

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 behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 3.7-115 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California, Oregon, and Washington Stock.

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. Non-auditory injury includes low severity injuries; following recovery, any long-term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that will 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 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 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, TTS, and PTS (see Figure 3.7-115 and tabular results in Appendix E). Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California, Oregon, and Washington Stock.

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 will 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.

Figure 3.7-115: Northern Right Whale Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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 identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for this species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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.

Pantropical Spotted Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

Pantropical spotted 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 TTS (see Figure 3.7-116 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-81).

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Three small and resident population areas for pantropical spotted dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the identified pantropical spotted dolphin small and resident population areas identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, pantropical spotted dolphin reactions to explosives are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on pantropical spotted dolphin natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of pantropical spotted 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 Explosives Under Alternative 1 for Testing Activities

Pantropical spotted 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 (see Figure 3.7-116 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges for Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-81).

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Three small and resident population areas for pantropical spotted dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosions However, sound from explosives could still expose animals within the identified pantropical spotted dolphin small and resident population areas identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, pantropical spotted dolphin reactions to explosives are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on pantropical spotted dolphin natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of pantropical spotted dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Figure 3.7-116: Pantropical Spotted Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No PTS or injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-81: Estimated Impacts on Individual Pantropical Spotted Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
4-Island	0%	50%
Oahu	47%	1%
Hawaii Pelagic	39%	39%
Hawaii Island	14%	9%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of pantropical spotted dolphins incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of pantropical spotted dolphins incidental to those activities.

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 behavioral reactions, TTS, and PTS (see Figure 3.7-117 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges for Explosives. Estimated impacts apply only to the California, Oregon, and Washington Stock.

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 will 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 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 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, TTS, and PTS (see Figure 3.7-117 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California, Oregon, and Washington Stock.

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 will 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.

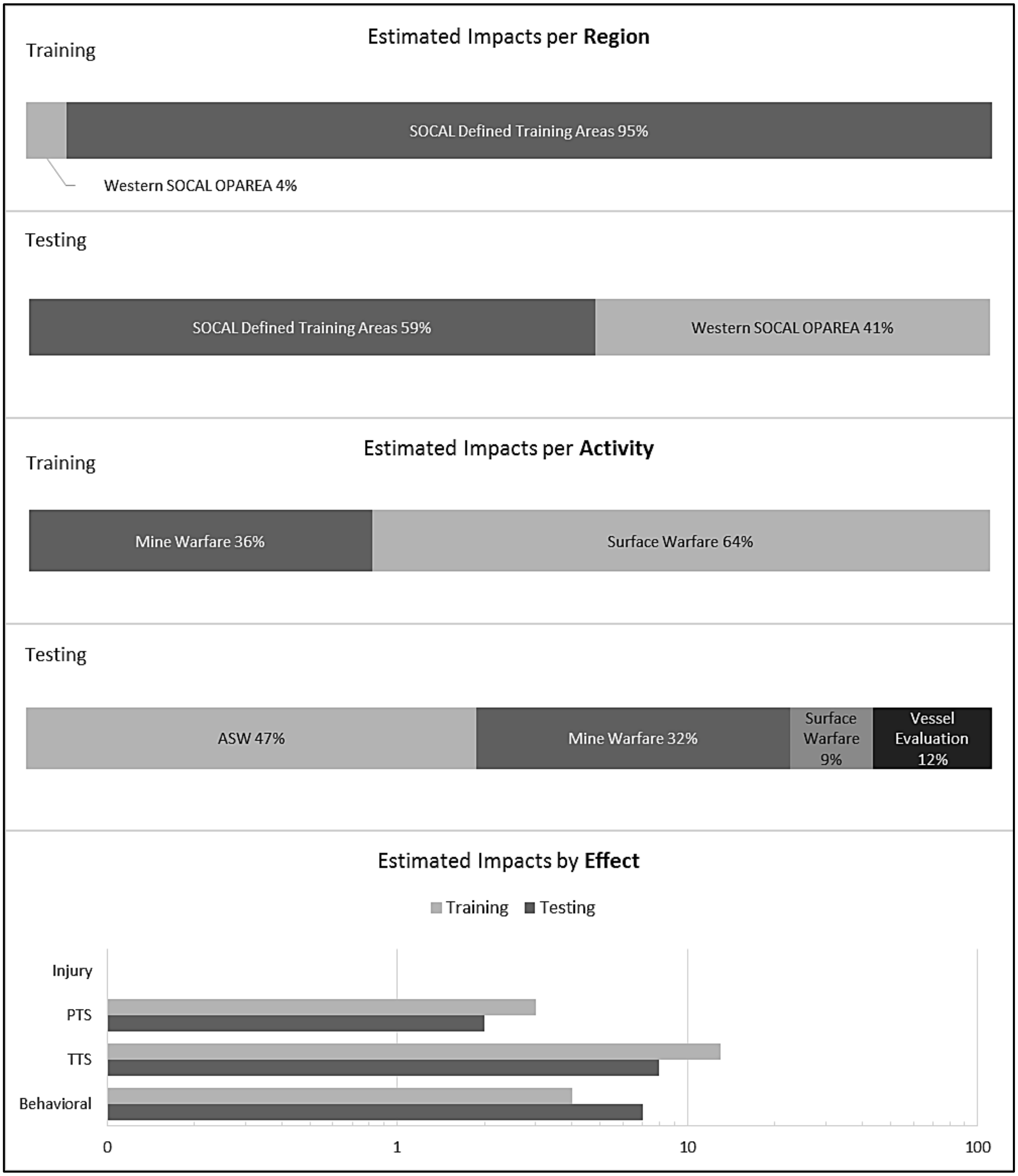


Figure 3.7-117: Pacific White-Sided Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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.

Pygmy Killer Whales

Impacts from Explosives Under Alternative 1 for Training Activities

Pygmy 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 TTS (see Figure 3.7-118 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A small and resident population area for pygmy killer whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the pygmy killer whale small and resident population area identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, pygmy killer whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on pygmy killer whale natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of pygmy killer 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 Explosives Under Alternative 1 for Testing Activities

Pygmy 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 TTS (see Figure 3.7-118 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A small and resident population area for pygmy killer whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the pygmy killer whale small and resident population area identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, pygmy killer whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on pygmy killer whale natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

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

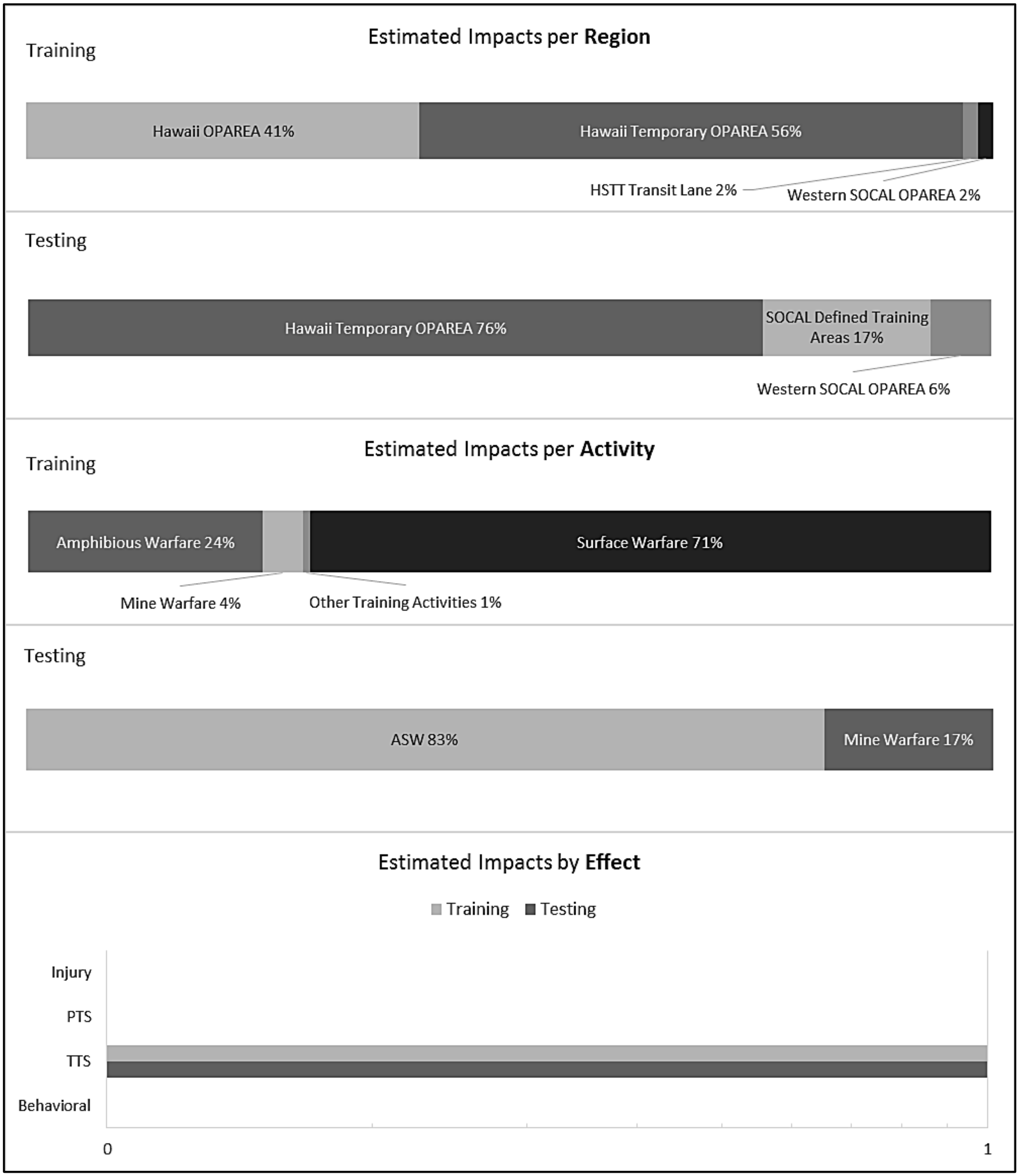


Figure 3.7-118: Pygmy Killer Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses, PTS, or injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-82: Estimated Impacts on Individual Pygmy Killer Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	98%	76%
Tropical	2%	24%

Impacts from Explosives Under Alternative 2 for Training Activities

Potential annual impacts on this 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 Training Activities. The primary distinction is that explosive use under Alternative 2 for training does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for this species from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of pygmy killer whales 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 identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for this species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of pygmy killer whales incidental to those activities.

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 behavioral reactions, TTS, and PTS (see Figure 3.7-119 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-83).

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 will 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 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.

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 behavioral reactions, TTS, and PTS (see Figure 3.7-119 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-83).

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 will 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 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.

Figure 3.7-119: Risso's Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-83: Estimated Impacts on Individual Risso's Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	2%	5%
California, Oregon, & Washington	98%	95%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of Risso's 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 identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for this species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of Risso's dolphins incidental to those activities.

Rough-Toothed Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

Rough-toothed dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year, although the quantitative analysis estimates that no rough-toothed dolphins would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

A small and resident population area for rough-toothed dolphins identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year round within the Hawaii Range Complex. This identified small and resident population area only takes up a very small portion Range Complex; therefore, explosive use in this area would be infrequent and typically only last for a short duration if it did occur. The sound from explosives could expose animals within the identified rough-toothed dolphin small and resident population area identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, rough-toothed dolphin reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on rough-toothed dolphin natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will not result in the unintentional taking of rough-toothed dolphins incidental to those activities.

Impacts from Explosives Under Alternative 1 for Testing Activities

Rough-toothed 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 (see Figure 3.7-120 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the Hawaiian Stock.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

A small and resident population area for rough-toothed dolphins identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year round within the Hawaii Range Complex. This identified small and resident population area only takes up a very small portion Range Complex; therefore, explosive use in this area would be infrequent and typically only last for a short duration if it did occur. The sound from explosives could expose animals within the identified rough-toothed dolphin small and resident population area identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, rough-toothed dolphin reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on rough-toothed dolphin natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of rough-toothed dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

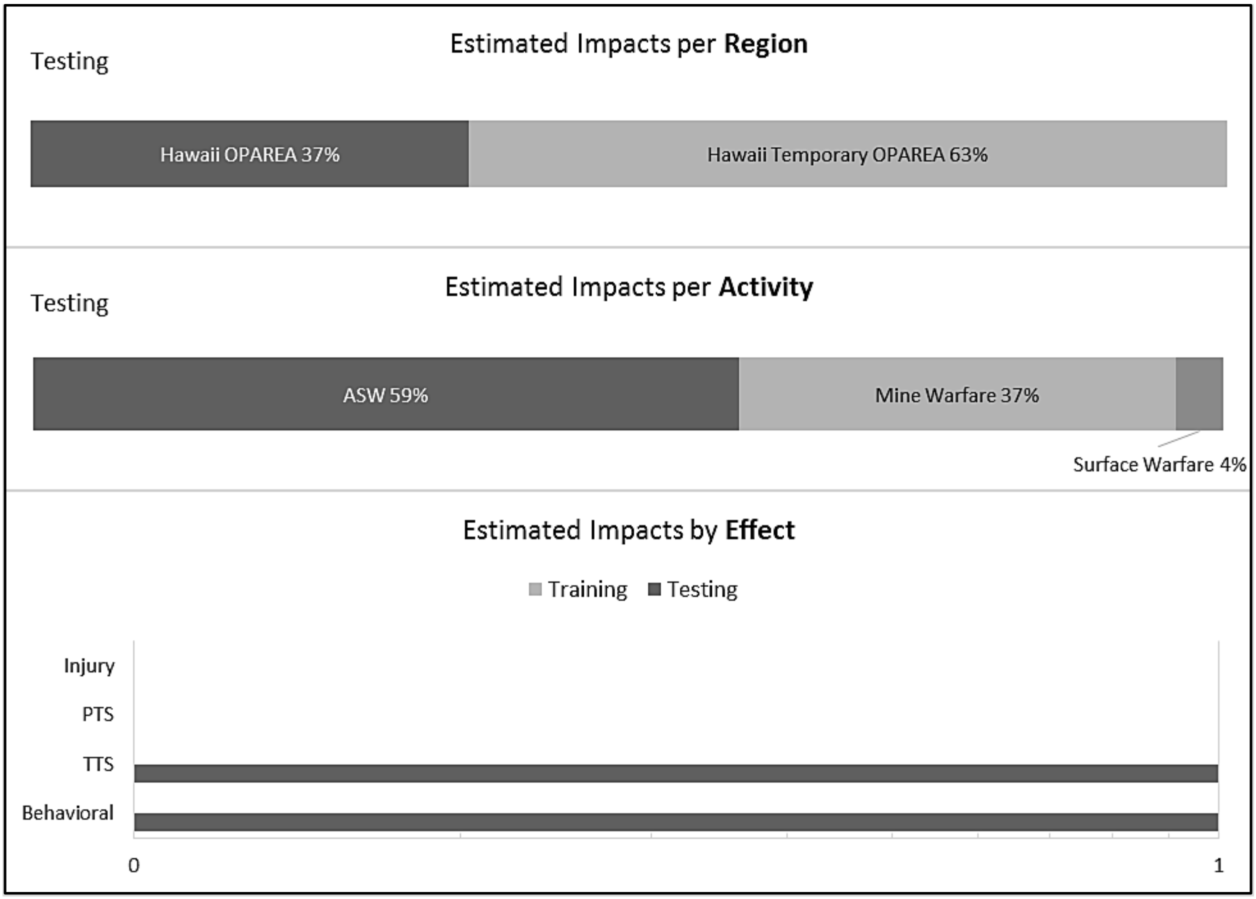


Figure 3.7-120: Rough-Toothed Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for training activities. No PTS or injuries (non-auditory) are estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

Impacts from Explosives Under Alternative 2 for Training Activities

Rough-toothed dolphins may be exposed to sound or energy from explosions associated with training activities under Alternative 2 throughout the year, although the quantitative analysis estimates that no rough-toothed dolphin would be impacted. Long-term consequences for individuals, 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 not result in the unintentional taking of rough-toothed 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 identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing Activities. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for this species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of rough-toothed 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 behavioral reactions, TTS, PTS, and (non-auditory) injuries (see Figure 3.7-121 and tabular results in Appendix E). In addition, the quantitative analysis estimates one mortality for short-beaked common dolphin from training activities (included under "Injury" in Figure 3.7-121). Estimated impacts most years would be less based on fewer explosions. Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California, Oregon, and Washington Stock.

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. Non-auditory injury includes low severity injuries; following recovery, any long-term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that will 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 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 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 behavioral reactions, TTS, PTS, and (non-auditory) injuries (see Figure 3.7-121 and tabular results in Appendix E). In addition, the quantitative analysis estimates one mortality for short-beaked common dolphin from testing activities. Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California, Oregon, and Washington Stock.

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. Non-auditory injury includes low severity injuries; following recovery, any long-term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that will 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 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.

Figure 3.7-121: Short-Beaked Common Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 Explosives Under Alternative 2 for Testing Activities

Potential annual impacts under Alternative 2 from testing with explosives would be nearly identical to the maximum use year impacts shown and discussed above in Impacts from Explosives Under Alternative 1 for Testing 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of short-beaked common dolphins incidental to those activities.

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 behavioral reactions, TTS, and PTS (see Figure 3.7-122 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-84).

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for short-finned pilot whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the short-finned pilot whale small and resident population area identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, short-finned pilot whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on short-finned pilot whale natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives 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 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 behavioral reactions and TTS (see Figure 3.7-122, and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-84).

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

A small and resident population area for short-finned pilot whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the short-finned pilot whale small and resident population area identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, short-finned pilot whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on short-finned pilot whale natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives 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.

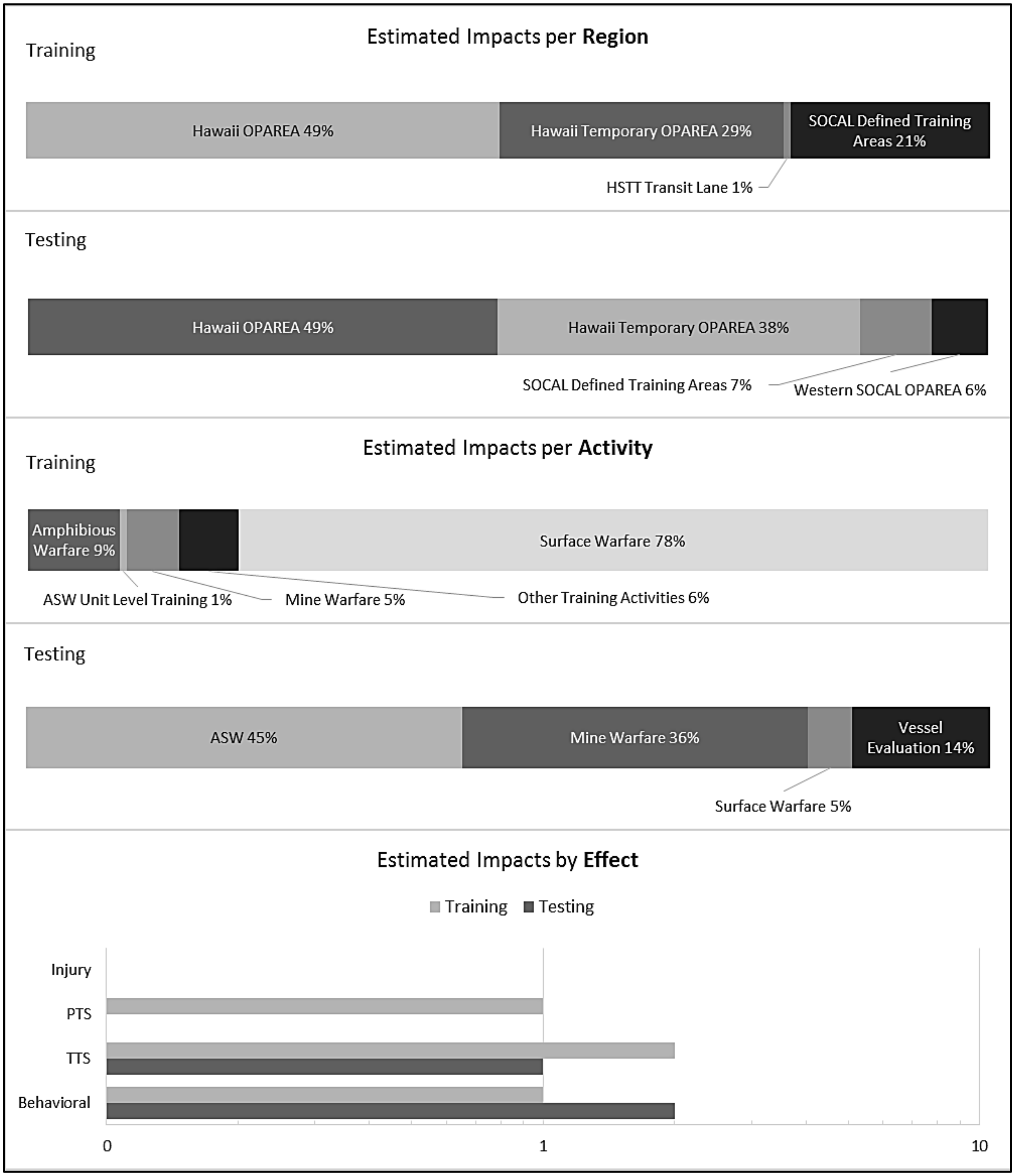


Figure 3.7-122: Short-Finned Pilot Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-84: Estimated Impacts on Individual Short-Finned Pilot Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	**Training**	**Testing**
Hawaiian	79%	87%
California, Oregon, & Washington	21%	13%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives 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 Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of short-finned pilot whales incidental to those activities.

Spinner Dolphins

Impacts from Explosives Under Alternative 1 for Training Activities

Spinner 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 behavioral reactions, TTS, and PTS (see Figure 3.7-123 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-85).

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Five small and resident population areas for spinner dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the identified spinner dolphin small and resident population areas identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, spinner dolphin reactions to sounds are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on spinner dolphin natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of spinner 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 Explosives Under Alternative 1 for Testing Activities

Spinner 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 (see Figure 3.7-123 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-85).

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stocks would not be expected.

Five small and resident population areas for spinner dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the identified spinner dolphin small and resident population areas identified by Baird et al. (2015) and some impacts on behavior could occur. As discussed above, spinner dolphin reactions to sounds are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts on spinner dolphin natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

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

Figure 3.7-123: Spinner Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-85: Estimated Impacts on Individual Spinner Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaii Pelagic	5%	19%
Hawaii Island	0%	2%
Oahu and 4-Island	95%	79%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of spinner dolphins incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of spinner dolphins incidental to those activities.

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 behavioral reactions, TTS, and PTS (see Figure 3.7-124 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-86).

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 will 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 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 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 behavioral reactions TTS, and PTS (see Figure 3.7-124 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges for Explosives. Estimated impacts apply to multiple stocks (see Table 3.7-86).

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 will 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 striped dolphins incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

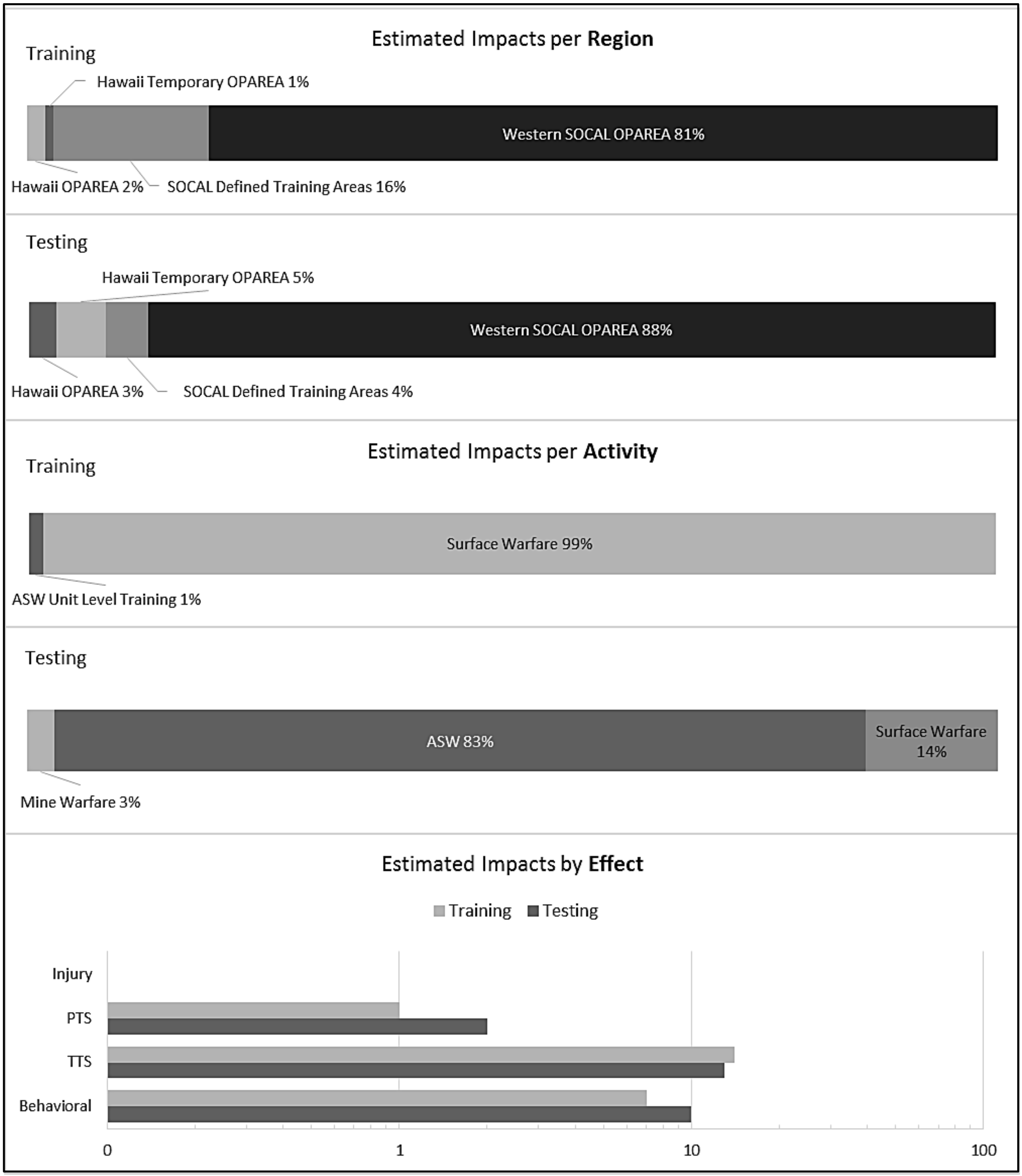


Figure 3.7-124: Striped Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW = Anti-Submarine Warfare

Table 3.7-86: Estimated Impacts on Individual Striped Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions Under Alternative 1

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	97%	92%
Hawaiian	3%	8%

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of striped dolphins incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking of striped dolphins incidental to those activities.

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). During the period that a Dall's porpoise had hearing loss, vocalizations from conspecifics could be more difficult to detect or interpret, however Dall's porpoises vocalize at frequencies above 100 kHz which is likely to be well above the frequency of threshold shift induced by sound from an explosion. Odontocetes, including the Dall's porpoise, use echolocation clicks to find and capture prey. These echolocation clicks and vocalizations are at frequencies above 100 kHz for Dall's porpoises and are therefore unlikely to be affected by threshold shift at lower frequencies. This should not affect Dall's porpoise's ability to locate prey or rate of feeding.

Research and observations (see *Behavioral Responses from Explosives*) show that harbor porpoises, a closely related species to Dall's porpoises, are sensitive to human disturbance including noise from impulsive sources. Observations of harbor porpoises near seismic surveys using air guns and pile driving operations show animals avoiding by 5–20 km, but returning quickly to the area after activities cease. Reactions could include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, change in vocalization, or showing no response at all. It is reasonable to expect that animals may leave an area of more intense explosive activity, but return within a few days, however most explosive use during Navy activities is short-duration consisting of only a single or few closely timed explosions 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 Dall's porpoises are likely to be short-term and moderate severity.

A few TTS or behavioral reactions in an individual animal within a given year are unlikely to result in any long-term consequences. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, a small threshold shift due to low-frequency sound from an explosion is unlikely to affect the hearing range that Dall's porpoises 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 stocks.

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 (see Figure 3.7-125 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California, Oregon, and Washington Stock.

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 will 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 (see Figure 3.7-125 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California, Oregon, and Washington Stock.

As described for other 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 will 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.

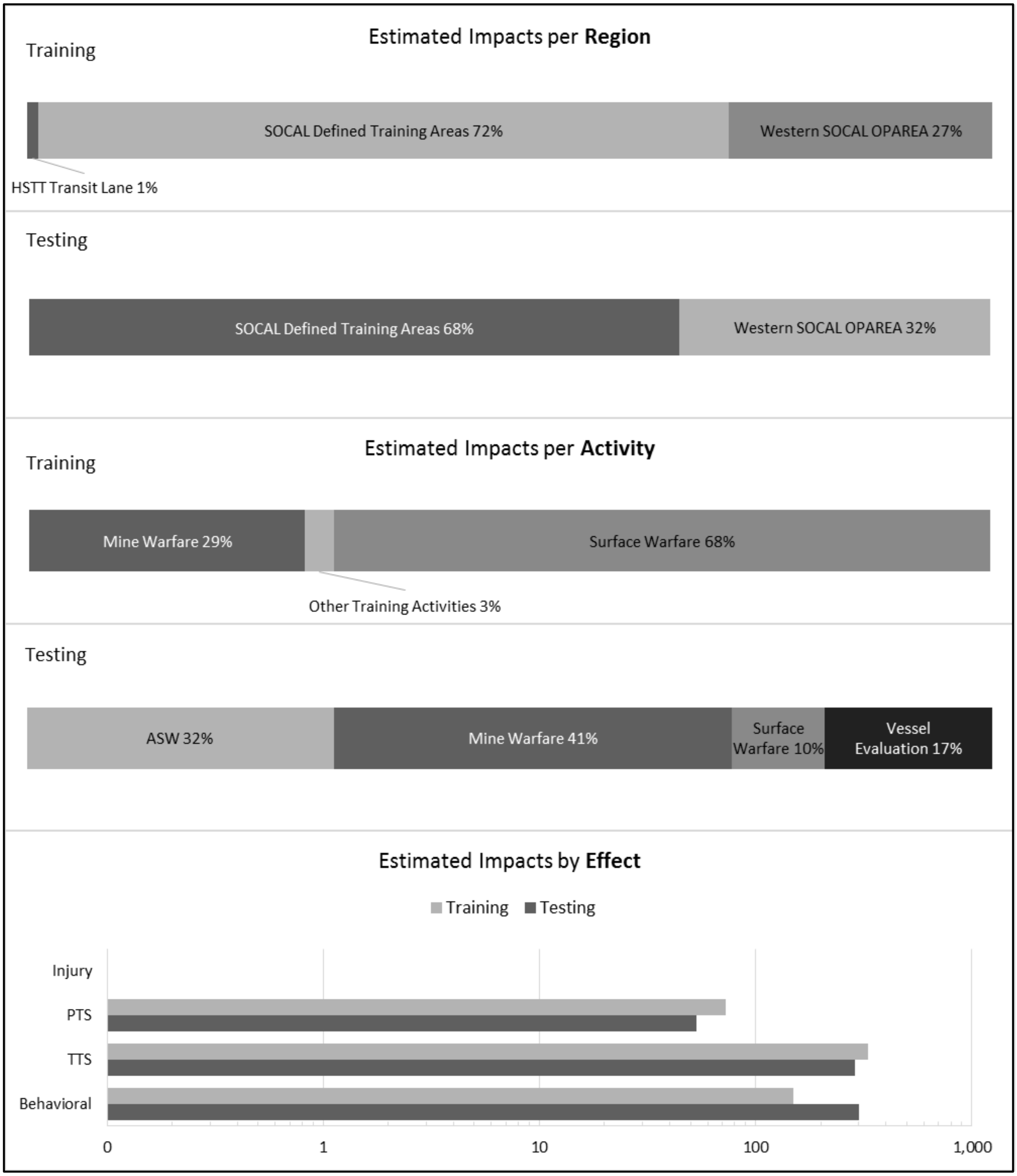


Figure 3.7-125: Dall's Porpoise Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100 percent California, Oregon, and Washington Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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

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. 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 number of impacts from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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.

Pinnipeds

Pinnipeds include phocid seals (true seals) and otariids (sea lions and fur seals). Pinnipeds 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 phocids and otariids (see Section 3.7.2.1.4, 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 phocids and otariids exposed to explosive sound and energy are discussed in Section 3.7.3.2.2.2 (Impact Ranges for Explosives).

Pinnipeds that do experience TTS from explosive sounds 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 3.7.3.1.1.4 (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 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 3.7.3.2.1.3, 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.

Guadalupe Fur Seals (Endangered Species Act-listed)

Guadalupe fur seals (Mexico stock is Endangered Species Act Listed) may be exposed to sound or energy from explosions associated with training or testing activities throughout the year, although the quantitative analysis estimates that no Guadalupe fur seals would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training or testing activities as described under Alternative 1 or 2 will not result in the unintentional taking of Guadalupe fur seals incidental to those activities.

Pursuant to the ESA, the use of explosives during training and testing activities as described under Alternative 1 or 2 will not affect ESA-listed Guadalupe fur seals.

Hawaiian Monk Seals (Endangered Species Act-listed)

Impacts from Explosives Under Alternative 1 for Training Activities

Hawaiian monk 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 (see Figure 3.7-126 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the Hawaiian Stock.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

As discussed in Section 3.7.2.2.9 (Hawaiian Monk Seal), the Study Area does overlap the marine portions of the Hawaiian monk seal critical habitat although the use of explosives generally does not take place within these areas. The sound and energy from explosives would not affect the designated essential features (i.e., marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 1 will result in the unintentional taking of Hawaiian monk 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 explosives during training activities as described under Alternative 1 may affect ESA-listed Hawaiian monk seals and would not affect Hawaiian monk seal critical habitats. 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

Hawaiian monk 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 and TTS (see Figure 3.7-126 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the Hawaiian Stock.

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 will be implemented as described in Chapter 5 (Mitigation), long-term consequences for the species or stock would not be expected.

As discussed in Section 3.7.2.2.9 (Hawaiian Monk Seal), the Study Area does overlap the marine portions of the Hawaiian monk seal critical habitat although the use of explosives generally does not take place within these areas. The sound and energy from explosives would not affect the designated essential features (i.e., marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 1 will result in the unintentional taking of Hawaiian monk 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 explosives during testing activities as described under Alternative 1 may affect ESA-listed Hawaiian monk seals and will not affect Hawaiian monk seal critical habitats. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Figure 3.7-126: Hawaiian Monk Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100 percent Hawaiian Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of Hawaiian monk seals incidental to those activities.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2 may affect ESA-listed Hawaiian monk seals and will not affect Hawaiian monk seal critical habitats.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for these species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking Hawaiian monk seals incidental to those activities.

Pursuant to the ESA, the use of explosives during testing activities as described under Alternative 2 may affect ESA-listed Hawaiian monk seals and will not affect Hawaiian monk seal critical habitats.

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 behavioral reactions, TTS, and PTS (see Figure 3.7-127 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California Stock.

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 will 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 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 for harbor seals (see Figure 3.7-127 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California Stock.

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 will 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 harbor seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

Figure 3.7-127: Harbor Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100 percent California Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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

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. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for these species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

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 behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 3.7-128 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California Stock.

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. Non-auditory injury includes low severity injuries; following recovery, any long-term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that will 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 (see Figure 3.7-128 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California Stock.

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 will 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.

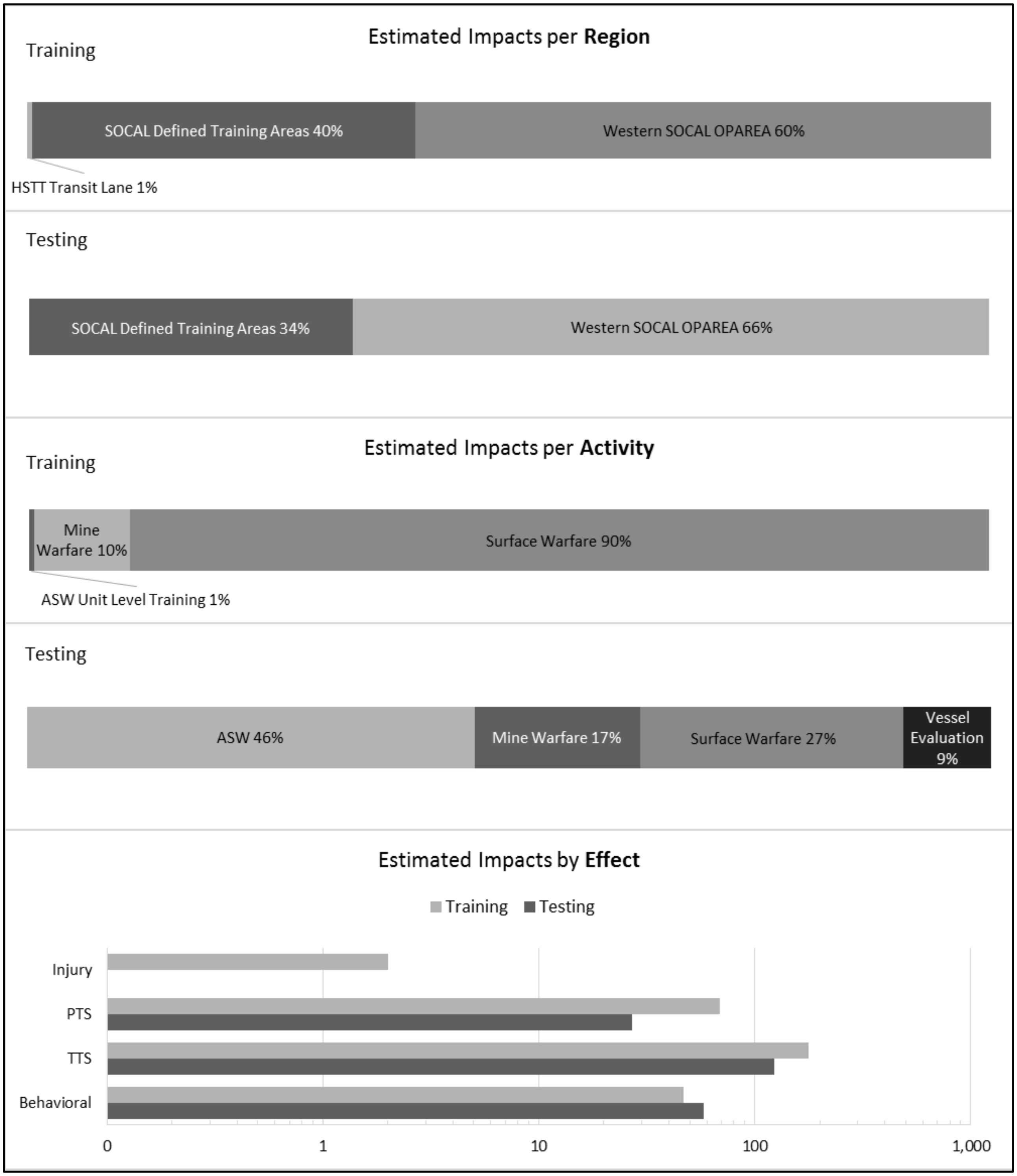


Figure 3.7-128: Northern Elephant Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. 100 percent California Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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

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. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for these species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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.

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 behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 3.7-129 and tabular results in Appendix E). In addition, the quantitative analysis estimates one mortality for California sea lions from training activities. Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the U.S. Stock.

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. Non-auditory injury includes low severity injuries; following recovery, any long-term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that will 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 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 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, and (non-auditory) injury for California sea lions (see Figure 3.7-129 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the U.S. Stock.

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. Non-auditory injury includes low severity injuries; following recovery, any long-term consequences to an individual are expected to be minor. Long-term consequences for the population are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that will 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.

Figure 3.7-129: California Sea Lion Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. 100 percent U.S. Stock. ASW = Anti-Submarine Warfare

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 number of impacts from training under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during training activities as described under Alternative 2 will result in the unintentional taking of California sea lions incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for these species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

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.

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 under Alternative 1 throughout the year, although the quantitative analysis estimates that no northern fur seals would be impacted. Long-term consequences for individuals, 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 not result in the unintentional taking of northern fur seals incidental to those activities.

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 behavioral reactions, TTS, and PTS (see Figure 3.7-130 and tabular results in Appendix E). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 3.7.3.2.2.2, Impact Ranges from Explosives. Estimated impacts apply only to the California Stock.

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 will 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 fur seals incidental to those activities. The Navy has requested authorization from NMFS as required by Section 101(a)(5)(A) of the MMPA.

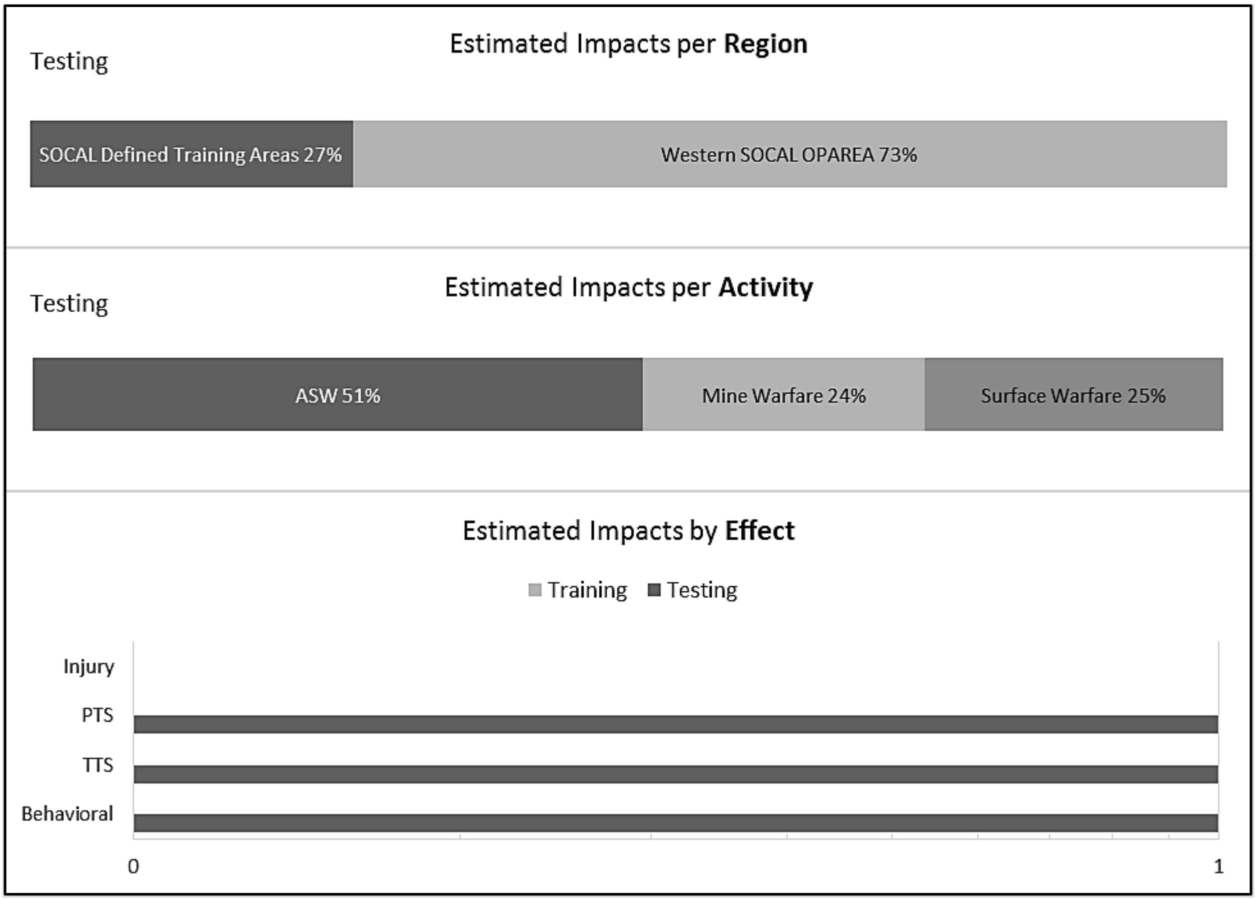


Figure 3.7-130: Northern Fur Seal Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under Alternative 1

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for training activities. No injuries (non-auditory) are estimated for this species. 100 percent California Stock. ASW = Anti-Submarine Warfare

Impacts from Explosives Under Alternative 2 for Training Activities

Northern fur seals may be exposed to sound or energy from explosions associated with training activities under Alternative 2 throughout the year, although the quantitative analysis estimates that no northern fur seals would be impacted. Long-term consequences for individuals, 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 not result in the unintentional taking of northern fur seals incidental to those activities.

Impacts from Explosives Under Alternative 2 for Testing Activities

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. The primary distinction is that explosive use under Alternative 2 for testing does increase slightly in some locations per year as compared to Alternative 1. Also, annual numbers of activities using explosives would be consistent year-to-year under Alternative 2 as compared to Alternative 1, which fluctuates annually. Therefore, over a multi-year period, the number of impacts for these species from testing under Alternative 2 may be greater than under Alternative 1 (see Appendix E).

Pursuant to the MMPA, the use of explosives during testing activities as described under Alternative 2 will result in the unintentional taking Northern fur seals incidental to those activities.

3.7.3.2.2.4 Impacts from Explosives Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Based on the analysis presented in Sections 3.7.3.2.2.3 (Impacts from Explosives Under Alternative 1) and 3.7.3.2.2.4 (Impacts from Explosives Under Alternative 2), impacts on individual marine mammals from explosive activities could occur under either alternative, but impacts on marine mammal populations are not anticipated. Therefore, discontinuing explosive activities under the No Action Alternative would remove the potential for impacts on individual marine mammals, but would not measurably improve the status of marine mammal populations or otherwise contribute to the recovery of threatened or endangered species that occur in the Study Area.

3.7.3.3 Energy Stressors

This section analyzes the potential impacts of energy stressors used during training and testing activities within the Study Area. This section includes analysis of the potential impacts of (1) in-water electromagnetic devices and (2) high-energy lasers. General discussion of impacts can also be found in Section 3.0.3.6.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities).

3.7.3.3.1 Impacts from In-Water Electromagnetic Devices

For a discussion of the types of activities that purposefully create an electromagnetic field underwater, refer to Appendix B (Activity Stressor Matrices), and for information on locations and the number of activities proposed for each alternative, see Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices). The devices producing an electromagnetic field are towed or unmanned mine countermeasure systems. The electromagnetic field is produced to simulate a vessel's magnetic field. In an actual mine clearing operation, the intent is that the electromagnetic field would trigger an enemy mine designed to sense a vessel's magnetic field.

Neither regulations nor scientific literature provide threshold criteria to determine the significance of the potential effects from actions that result in generation of an electromagnetic field. Data regarding the influence of electromagnetic fields on cetaceans are inconclusive and are based primarily on the assumptions that marine mammals can sense variations in the earth's magnetic field and that they use those magnetic field variations for navigation. There has been renewed interest in this topic of inquiry given the unknown potential for electromagnetic fields generated by undersea power cables to possibly affect geo-navigation in migrating marine mammals (Gill et al., 2014; Kremers et al., 2014; Kremers et al., 2016b; Zellar et al., 2017). Horton et al. (2017) have indicated that future experiments involving empirical observation of free-ranging animals are still required for there to be sufficient evidence demonstrating causal relations between marine mammal movement decisions and environmental cues such as the earth's magnetic field.

Most of the early research in this regard involved investigating the correlation of the locations where live-stranded animals occurred to determine if there was an associated local variation in the earth's magnetic field (Kirschvink et al., 1986; Kirschvink, 1990; Klinowska, 1985; Walker et al., 1992). Species included long-finned and short-finned pilot whales, striped dolphin, Atlantic spotted dolphin, Atlantic white-sided dolphin, fin whale, common dolphin, harbor porpoise, sperm whale, and pygmy sperm whale which had live-stranding locations correlated with areas where the earth's magnetic field was locally weaker than surrounding areas (Kirschvink, 1990). These statistical associations for locally weaker areas represented a total intensity variation of less than 0.05 microtesla in the magnetic field (Kirschvink et al., 1986). While this correlation had seemed to have also been demonstrated for bottlenose dolphins in the Atlantic (Kirschvink et al., 1986), there was no correlation found in the Pacific (Kirschvink, 1990). Subsequent research regarding fin whale sightings over the continental shelf off the northeastern United States, were consistent with the findings involving stranded fin whales (Kirschvink, 1990), the hypothesis that fin whales possess a magnetic sense, and that they use it to migrate (Walker et al., 1992). Bureau of Ocean Energy Management (2011) reviewed available information on electromagnetic and magnetic field sensitivity of marine organisms (including marine mammals) for impact assessment of offshore wind farms for the U.S. Department of the Interior and concluded there is no evidence to suggest any magnetic sensitivity for sea lions, fur seals, or sea otters. However, the Bureau of Ocean Energy Management (2011) concluded there was behavioral, anatomical, and theoretical evidence indicating cetaceans sense magnetic fields.

Anatomical evidence suggests the presence of magnetic material in the brain (Pacific common dolphin, Dall's porpoise, bottlenose dolphin, Cuvier's beaked whale, and the humpback whale) and in the tongue and lower jawbones (harbor porpoise) (Bauer et al., 1985; Kirschvink, 1990). Zoeger et al. (1981) found what appeared to be nerve fibers associated with the magnetic material in a Pacific common dolphin and proposed that it may be used as a magnetic field receptor. Electrosensitivity was found in the Guiana dolphin (Czech-Damal et al., 2011). Kuzhetsov (1999) conducted experiments exposing bottlenose dolphins to permanent magnetic field intensities of 32, 108, and 168 microteslas and showed both behavioral and physiological reactions during 79 percent, 63 percent, and 53 percent of the trials, respectively (as summarized in Bureau of Ocean Energy Management (2011)). Behavioral reactions included sharp exhalations, acoustic activity, and movement, and physiological reactions included a change in heart rate. Kremers et al. (2014) conducted another experiment to observe the spontaneous reactions of captive bottlenose dolphins from a magnetized device compared to a demagnetized device. Results from this experiment confirmed that dolphins are capable of perceiving magnetic fields from a distance of more than 1.5 m from the 1.2 tesla magnetic strength device; creating a magnetic field with a strength of approximately 0.051 – 0.240 tesla between two to five centimeters from the source (Kremers et al., 2014). The dolphins approached the magnetized device with shorter latency compared to the demagnetized device that was identical in form and density and otherwise undistinguishable through echolocation (Kremers et al., 2014). The findings also suggest that dolphins may be able to discriminate between two items based on their magnetic properties (Kremers et al., 2016a). It is still unclear whether magnetic fields are attractive or repulsive to dolphins (Kremers et al., 2014; Kremers et al., 2016a) and further studies on the magnetic perception threshold on dolphin behavior need to be conducted (Kremers et al., 2016a).

Potential impacts on marine mammals associated with electromagnetic fields are most likely dependent on the animal's proximity to the source and the strength of the magnetic field. Because the device creating the electromagnetic field is towed or is on an unmanned vehicle, it may not be possible to distinguish whether an avoidance reaction of an animal is the result of physical disturbance from the towed object or unmanned vehicle (see Section 3.7.3.4.1, Impacts from Vessels and In-Water Devices) or from the presence of the electromagnetic field. As discussed in Section 3.0.3.3.3.1 (Electromagnetic Devices), electromagnetic fields associated with naval training and testing activities are relatively weak (only 10 percent of the earth's magnetic field at approximately 24 m), temporary, and localized. Once the source is turned off or moves from the location, the electromagnetic field is gone. A marine mammal would have to be present within the electromagnetic field (approximately 200 m from the source) during the activity in order to detect it.

NMFS has previously determined: "Impacts of exposure to electromagnetic stressors are not expected to result in substantial changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts" for representative mysticetes, odontocetes, and pinnipeds in the HSTT Study Area (National Marine Fisheries Service, 2015f). There has been no new science subsequent to that determination that would suggest a different conclusion.

3.7.3.3.1.1 Impacts from In-Water Electromagnetic Devices Under Alternative 1

<u>**Impacts from In-Water Electromagnetic Devices Under Alternative 1 for Training Activities**</u>

As discussed in Section 3.0.3.3.3.1 (Electromagnetic Devices), under the Alternative 1, training activities that purposefully create an electromagnetic field underwater occur within both the Hawaii and the Southern California portions of the Study Area and have the potential to expose marine mammals to that energy stressor. Based on the discussion above, exposure to electromagnetic stressors are not expected to result in significant impacts on individual marine mammals or marine mammal populations during training activities.

Although it is not fully understood, based on the available evidence described above, it is probable that marine mammals use the earth's magnetic field for orientation or migration (Walker et al., 1992). If a marine mammal was in proximity of an electromagnetic field source associated with navy training and testing, emitting a field strong enough to be detected, and that animal is sensitive to the exposure, it is conceivable that this electromagnetic field could have an effect on a marine mammal, primarily impacting that animal's navigation. Available literature on marine mammals involve investigating their ability to sense an electromagnetic field due to the potential it then may have on navigation and migration behaviors. Direct impacts on feeding or reproductive behaviors have not been documented and impacts on marine mammals feeding and engaging in reproductive behaviors are not anticipated. If marine mammals are in fact sensitive to small variations in electromagnetic fields, any impacts from Navy training and testing would be temporary and minor, and natural behavioral patterns would not be significantly altered or abandoned based on the Navy's in-water electromagnetic device having (1) generated a relatively low intensity magnetic field (essentially mimicking the magnetic field of a steel vessel); (2) a very localized magnetic field proximate to the moving in-water electromagnetic device; (3) as stated in Chapter 5 (Mitigation), the Navy maneuvers vessels and towed in-water devices to maintain a specified distance away from marine mammals, which consequently would provide some avoidance of in-water electromagnetic devices that are towed from manned platforms; and (4) the training and testing use of such an in-water electromagnetic device being of short duration (hours).

In-water electromagnetic device use associated with Navy training in Hawaii would only occur in Pearl Harbor and so would not occur in the critical habitat of the Hawaiian monk seal.

The use of in-water electromagnetic devices during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of in-water electromagnetic devices during training activities as described under Alternative 1 would have no effect on Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from In-Water Electromagnetic Devices Under Alternative 1 for Testing Activities

As discussed in Section 3.0.3.3.3.1 (Electromagnetic Devices), under the Alternative 1, testing activities that purposefully create an electromagnetic field underwater occur within the Hawaii Range Complex and Southern California portion of the Study Area and have the potential to expose marine mammals to that energy stressor. Based on the discussion above, exposure to electromagnetic stressors are not expected to result in significant impacts on individual marine mammals or marine mammal populations during testing activities.

The use of in-water electromagnetic devices during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of in-water electromagnetic devices during testing activities as described under Alternative 1 would have no effect on Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.7.3.3.1.2 Impacts from In-Water Electromagnetic Devices Under Alternative 2

Impacts from In-Water Electromagnetic Devices Under Alternative 2 for Training Activities

As discussed in Section 3.0.3.3.3.1 (Electromagnetic Devices), training activities and associated impacts for Alternative 2 would be identical to Alternative 1 (Section 3.7.3.3.1.1).

The use of in-water electromagnetic devices during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of in-water electromagnetic devices during training activities as described under Alternative 2 would have no effect on Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals.

Impacts from In-Water Electromagnetic Devices Under Alternative 2 for Testing Activities

As discussed in Section 3.0.3.3.3.1 (Electromagnetic Devices), testing activities and associated impacts for Alternative 2 would be identical to Alternative 1 (Section 3.7.3.3.1.1).

The use of in-water electromagnetic devices during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of in-water electromagnetic devices during training activities as described under Alternative 2 would have no effect on Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals.

3.7.3.3.1.3 Impacts from In-Water Electromagnetic Devices Under the No Action Alternative

Impacts from In-Water Electromagnetic Devices Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various energy stressors (e.g., in-water electromagnetic devices) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.7.3.3.2 Impacts from In-Air Electromagnetic Devices

The use of in-air electromagnetic devices associated with Navy training and testing activities is not applicable to cetaceans because in-air electromagnetic energy does not penetrate the ocean. For pinnipeds that may be hauled out, in-air electromagnetic sources used during training or testing will never be in close enough proximity to those land based haulouts to have an effect on those animals. As a result, in-air electromagnetic devices will not be analyzed further in this section.

3.7.3.3.3 Impacts from High-Energy Lasers

As discussed in Section 3.0.3.3.3.2 (Lasers), high-energy laser weapons activities involve evaluating the effectiveness of an approximately 30 kilowatt high-energy laser 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 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 in a worst-case scenario. Model input values include high-energy laser use data (e.g., number of high-energy laser events and laser beam footprint), size of the testing area, marine mammal density data, and animal footprint. To estimate the probability of hitting a marine mammal in a worst-case scenario (based on assumptions listed below), the impact area for all high-energy laser testing events was summed over one year in the testing area for each alternative. Finally, the marine mammal species with the highest average seasonal density within the testing 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 the laser.

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; Costa & Block, 2009).
- 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.

3.7.3.3.3.1 Impacts from High-Energy Lasers Under Alternative 1

Impacts from High-Energy Lasers Under Alternative 1 for Training Activities

No high-energy lasers are used during training activities under Alternative 1.

Impacts from High-Energy Lasers Under Alternative 1 for Testing Activities

As discussed in Section 3.0.3.3.3.2 (Lasers), under Alternative 1, high-energy laser tests would occur within the Hawaii Range Complex and Southern California Range Complex. Navy testing activities have the potential to expose marine mammals that occur within these locations to this energy stressor.

The marine mammal species with the highest average seasonal density (short beaked common dolphin) in the location with the greatest number of testing activities involving high-energy lasers under Alternative 1 (Southern California Range Complex) was used in the probability analysis presented in Appendix F (Military Expended Material and Direct Strike Impact Analyses).

Based on the statistical probability model presented in Appendix F (Military Expended Materials and Direct Strike Impact Analyses), results indicate that even for short-beaked common dolphins and using conservative assumptions, the probability of being hit by a high-energy laser is low enough to be discountable. Considering the assumptions in the analysis 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.

Navy testing activities that use high-energy lasers may occur in locations overlapping the MHI insular false killer whale critical habitat, but would not likely occur within the designated Hawaiian monk seal critical habitat since the outer boundaries of the critical habitat are relatively close to the shorelines of the main Hawaiian Islands. Given the high level of certainty that no marine mammals would be struck by a high-energy laser, the Navy does not anticipate it would strike a MHI insular false killer whale or a monk seal with a high-energy laser during testing activities.

The use of high-energy lasers during testing activities as described under Alternative 1 would not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of high-energy lasers during testing activities as described under Alternative 1 would have no effect on MHI insular false killer whale or Hawaiian monk seal critical habitats and may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA in that regard.

3.7.3.3.3.2 Impacts from High-Energy Lasers Under Alternative 2

Impacts from High-Energy Lasers Under Alternative 2 for Training Activities

No high-energy lasers are used during training activities under Alternative 2.

Impacts from High-Energy Lasers Under Alternative 2 for Testing Activities

As discussed in Section 3.0.3.3.3.2 (Lasers), the locations, numbers of activities, and potential effects associated with high-energy lasers use would be the same under Alternatives 1 and 2. Refer to Section 3.7.3.3.2.1 (Impacts from High-Energy Lasers Under Alternative 1) for a discussion of impacts on marine mammals.

The use of high-energy lasers during testing activities as described under Alternative 2 would not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

The use of high-energy lasers during testing activities as described under Alternative 2 would have no effect on MHI insular false killer whale or Hawaiian monk seal critical habitats and may affect ESA-listed marine mammals.

3.7.3.3.3.3 Impacts from High-Energy Lasers Under the No Action Alternative

Impacts from High-Energy Lasers Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various energy stressors (e.g., high-energy lasers) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.7.3.3.4 Impacts from In-Air Electromagnetic Devices

The use of in-air electromagnetic devices associated with Navy training and testing activities is not applicable to cetaceans because in-air electromagnetic energy does not penetrate the ocean. For pinnipeds that occur on land, in-air electromagnetic sources used during training or testing will never be in close enough proximity to those land based haulouts to have an effect on those animals. As a result, in-air electromagnetic devices will not be analyzed further in this section.

3.7.3.4 Physical Disturbance and Strike Stressors

This section analyzes the potential impacts of the various types of physical disturbance including the potential for strike during training and testing activities within the Study Area from (1) Navy vessels, (2) in-water devices, (3) military expended materials, including non-explosive practice munitions and fragments from high-explosive munitions; (4) seafloor devices, (5) and pile driving with the resulting Elevated Causeway System. General discussion of impacts can also be found in Section 3.0.3.6.3 (Conceptual Framework for Assessing Effects from Physical Disturbance or Strike).

The way a physical disturbance may affect a marine mammal would depend in part on the relative size of the object, the speed of the object, the location of the mammal in the water column, and reactions of marine mammals to anthropogenic activity, which may include avoidance or attraction. It is not known at what point or through what combination of stimuli (visual, acoustic, or through detection in pressure changes) an animal becomes aware of a vessel or other potential physical disturbances prior to reacting or being struck. Refer to Sections 3.7.3.1.1.3 (Physiological Stress) and 3.7.3.1.1.5 (Behavioral Reactions) for the discussion of the potential for disturbance from acoustic stimuli. Given that the presentation of a physical disturbance should be very rare and brief, the cost from the response is likely to be within the normal variation experienced by an animal in its daily routine unless the animal is struck. If a strike does occur, the cost to the individual could range from slight injury to death.

3.7.3.4.1 Impacts from Vessels and In-Water Devices

Vessels

Surface vessels in certain contexts can be a source of acute and chronic disturbance for cetaceans (Au & Green, 2000; Bejder et al., 2006a; Dyndo et al., 2015; Hewitt, 1985; Lusseau et al., 2009; Magalhães et al., 2002; Nowacek et al., 2004a; Nowacek et al., 2007; Nowacek et al., 2004b; Richter et al., 2003; Richter et al., 2006; Van der Hoop et al., 2015; Watkins, 1986; Würsig & Richardson, 2009). Studies have established that cetaceans generally engage in avoidance behavior when surface vessels move toward them. Various research findings report that mysticetes have variable responses to vessels dependent on the context (Nowacek et al., 2004a; Richardson et al., 1995b; Watkins, 1986). Mysticetes are not the only cetaceans that have demonstrated responses to vessels. One study showed that harbor porpoises in a net-pen displayed behavioral responses (increasing swim speed or repeated alternating surfacing and diving behaviors [i.e., porpoising]) to the high-frequency components of vessel noise at long ranges (more than 1,000 m) in shallow waters (Dyndo et al., 2015). These distances correspond to where radiated noise would be more likely to elicit the response, rather than physical presence of the vessel (Dyndo et al., 2015; Palka & Hammond, 2001). Conversely, another study demonstrated that physical presence of a vessel, and not just noise, was associated with a short-term reduction in foraging activity in bottlenose dolphins (Pirotta et al., 2015b). It is noteworthy that the dolphins associated with this report were exposed primarily to commercial and leisure boat traffic, not related to military vessel activities. Even repeated exposures from increasing vessel traffic in the same area resulting in increased responses to the disturbance may not be biologically significant. Mathematic modeling has suggested that bottlenose dolphin population dynamics would remain unchanged from a six fold increase in vessel traffic (70 to 470 vessels per year) as dolphins are able to compensate for increased disturbance levels with little to no impacts on health and vital rates (New et al., 2013a). Aside from the potential for an increased risk of collision addressed below, physical disturbance from vessel use is not expected to result in more than a short-term behavioral response.

Hauled out pinnipeds are also disturbed when approached at close distance although the research indicates this is somewhat context dependent (Curtin et al., 2009; Hoover-Miller et al., 2013; Jansen et al., 2010; Johnson & Acevedo-Gutiérrez, 2007; Suryan & Harvey, 1998; Weiss & Morrill, 2014; Young et al., 2014). For example, one study showed that harbor seals were disturbed by tourism-related vessels, small boats, and kayaks that stopped or lingered by haulout sites, but that the seals “do not pay attention to” passing vessels at closer distances (Johnson & Acevedo-Gutiérrez, 2007). Pinnipeds in the water generally appear less responsive (Richardson et al., 1995b) than those at haulout sites.

In some circumstances, marine mammals respond to vessels with the same behavioral repertoire and tactics they employ when they encounter predators. Although it is not clear what environmental cue or cues marine animals might respond to, they may include the sounds of water being displaced by the ships, the sounds of the ships’ engines, or a combination of environmental cues surface vessels produce while they transit. While the analysis of potential impact from the physical presence of the vessel is presented here, the analysis of potential impacts in response to sounds produced by vessel movement or transit is addressed in Section 3.7.3.1.5 (Impacts from Vessel Noise).

Vessel speed, size and mass are all important factors in determining potential impacts of a vessel strike to marine mammals (Conn & Silber, 2013; Gende et al., 2011; Silber et al., 2010; Vanderlaan & Taggart, 2007; Wiley et al., 2016). For large vessels, speed and angle of approach can influence the severity of a strike. Based on modeling, Silber et al. (2010) found that whales at the surface experienced impacts that increased in magnitude with the ship’s increasing speed.

Vessel strikes from commercial, recreational, and Navy vessels are known to have resulted in serious injury and occasional fatalities to cetaceans (Abramson et al., 2011; Berman-Kowalewski et al., 2010; Calambokidis, 2012; Laggner, 2009; Lammers et al., 2003; Van der Hoop et al., 2012; Van der Hoop et al., 2013; Van der Hoop et al., 2015). Reviews of the literature on ship strikes mainly involve collisions between commercial vessels and whales (e.g., Jensen (2003); Laist et al. (2001)).

In the HSTT Study Area, comparison of commercial vessel traffic with Navy vessel traffic over a 1-year period showed that Navy surface ships accounted for 97,000 hours of accumulated at-sea time whereas commercial shipping accounted for 875,000 hours (Mintz, 2012). Therefore, Navy ship activity represented only 11 percent of all vessel hours within the HSTT Study Area, but it should be noted that Navy vessels in the Pacific often stop or move slowly at sea depending on mission requirements and fuel saving mandates. Navy vessels, given they are much fewer in number, are a small component of overall vessel traffic in most areas where they operate and this is especially the case in the HSTT Study Area (National Marine Fisheries Service, 2015f).

Within the Hawaii portion of the HSTT Study Area, significant commercial traffic is present as vessels bring shipments of goods to Hawaii as well as shipments between the islands. There are, however, a much greater number of vessels from major ports in Asia (such as Shanghai, China) that pass through the HSTT area and between some of the main Hawaiian Islands en route to the Panama Canal and back.

Within the Southern California portion of the HSTT Study Area, evidence of significant mortality of species of baleen whales (mostly from data on blue, fin, and humpback whales) from commercial ship strikes in the Santa Barbara Channel of Southern California have prompted a detailed analysis of the situation and how it can be resolved. There are approximately 6,500 commercial vessels annually using the Santa Barbara Channel (Channel Islands National Marine Sanctuary, 2015). For San Diego Bay and its entrance channel, there are about 225 commercial ship transits per day, most during daylight hours, plus an unknown but potentially equal number of recreational vessels moving in and out of San Diego Bay so that underwater noise from passing ships is expected every few minutes in the North Bay (U.S. Department of the Navy, 2013a, 2015b). An additional large number of vessels also transit farther offshore along the coast heading to ports beyond those in Southern California. Stranding locations also appeared to be concentrated near major Southern California ports suggesting they are likely indicative of commercial vessel interactions (Berman-Kowalewski et al., 2010). This area appears to be highly problematic, largely because it represents an overlap of important feeding grounds for these species of whale with a major shipping lane to/from Southern California ports (see Abramson et al. (2011)). Between 1988 and 2007, 21 blue whale deaths were reported along the California coast, and many of these showed evidence of ship strike (Berman-Kowalewski et al., 2010). In 2007, National Oceanic and Atmospheric Administration declared an Unusual Mortality Event for endangered blue whales in Southern California as a result of commercial vessel ship strikes in that year. Several recommendations have been put forward to reduce the potential for future ship strikes in the area of Southern California commercial ports, including (1) continuing and expanding scientific studies, (2) considering changing shipping patterns and lanes, (3) exploring incentives for reducing shipping speeds, (4) expanding education and outreach, and (5) adaptive management approaches.

Large Navy vessels (greater than 18 m in length) within the offshore areas of the HSTT 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. By comparison, this is slower than most commercial vessels where full 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 is generally a reduction of only a few knots given 21 knots would be considered slow; 18 knots is defined as extra slow; and 15 knots is considered super slow (Bonney & Leach, 2010), which all exceed the typical Navy large vessel average speed.

The ability 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. Differences between most Navy ships and commercial ships also include the following:

- The Navy has several standard operating procedures for vessel safety that will benefit marine mammals through a reduction in the potential for vessel strike, as discussed in Section 2.3.3.2 (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 (underway). Watch personnel undertake extensive training to certify that they have demonstrated all necessary skills. While on watch, personnel employ visual search and reporting procedures in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent. Watch personnel are responsible for using correct scanning procedures while monitoring an assigned sector and report any indication of danger to the ship and personnel on board, such as a floating or partially submerged object or piece of debris, periscope, surfaced submarine, wisp of smoke, flash of light, or surface disturbance. As a standard collision avoidance procedure, watch personnel also monitor for marine mammals that have the potential to be in the direct path of the ship. Navy vessels are required to operate in accordance with applicable navigation rules, including Inland Navigation Rules (33 CFR 83) and the International Regulations for Preventing Collisions at Sea (72 COLREGS), which were formalized in the Convention on the International Regulations for Preventing Collisions at Sea, 1972. Applicable navigation requirements include, but are not limited to, Rule 5 (Lookouts) and Rule 6 (Safe Speed). These rules require that vessels at all times proceed at a safe speed so that proper and effective action can be taken to avoid collision and so they can be stopped within a distance appropriate to the prevailing circumstances and conditions.

- 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 Navy's 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 the need to change direction is necessary.
- Navy ships operate at the slowest speed possible consistent with either transit needs or training or testing needs. While minimum speed is intended as a fuel conservation measure particular to a certain ship class, secondary benefits include better ability 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 1 day to 2 weeks as compared to straight line point-to-point commercial shipping.
- Navy overall crew size, including bridge crew, is much larger than merchant ships allowing for more potential watch personnel 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 or reduce 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), and requiring vessels to maneuver to maintain a specified distance from marine mammals during vessel movements.

Examples of implemented mitigation to avoid collisions with whales includes data presented to NMFS regarding Major Exercises in the Southern California Range Complex from January 2009 to August 2012 involving 27 Major Exercises. That report documented 42 reported instances of Navy ships proactively maneuvering to avoid 72 whales during that 3-year period (U.S. Department of the Navy, 2013a); See also Section 5.1.1 (Monitoring, Research, and Reporting Initiatives).

It is Navy policy to report all marine mammal strikes by Navy vessels. The information is collected by Office of the Chief of Naval Operations Environmental Readiness Division and provided to NMFS on an annual basis. Only Navy and the U.S. Coast Guard report in this manner. Therefore, it should be noted that Navy vessel strikes reported in the scientific literature and NMFS databases are the result of the Navy's commitment to reporting all vessel strikes to NMFS (even if it cannot be confirmed to be a marine mammal) rather than a greater frequency of collisions relative to other ship types, particularly commercial vessels. Most vessel strikes of marine mammals involve commercial vessels and occur over or near the continental shelf (Laist et al., 2001). Reporting of whale strikes by commercial vessels is not required and reporting rates are therefore unknown, but likely to be much lower than actual occurrences.

Since the implementation of the Navy's Marine Species Awareness Training in 2007, refined policy guidance has been issued regarding marine mammal incidents (e.g., ship strikes) in order to collect the most accurate and detailed data possible in response to a possible incident. Mitigation, reporting, and monitoring requirements have been in place with routine implementation since 2009 and these same requirements are expected to continue into the future. The level of vessel use and the manner in which the Navy trains and tests in the future (2019–2023) is expected to be consistent with the 2009 to 2016 time period, so data from this past nine-year period have been used to calculate the probability of a Navy vessel striking a whale during proposed training activities in the Study Area as detailed in Appendix F. From January 2009 through December 2016, a total of two (2) whale strikes occurred during Navy training and testing activities in the HSTT Study Area; both strikes were to fin whales and both occurred in 2009 in the Southern California Range Complex.

Based on the cumulative low history of Navy vessel strikes from 2009 to 2016, the decrease in Navy strike incidents (zero since 2009) since introduction of the Marine Species Awareness Training, and adaptation of additional mitigation measures since 2009, the Navy does not anticipate vessel strikes to marine mammals within the HSTT Study Area during training and testing activities under any of the alternatives. Based on the Appendix F probabilities and in cautionary acknowledgment that the probability of a ship strike, although low, could occur over a five-year authorization, the Navy is electing to request a small number of takes to select large whale stocks from vessel strikes for HSTT. The exact magnitude of this request will be determined at the conclusion of the Marine Mammal Protection Act and Endangered Species Act consultations with NMFS.

Mysticetes

Vessel strikes have been documented for almost all of the mysticete species (Van der Hoop et al., 2012; Van der Hoop et al., 2013; Van der Hoop et al., 2015). This includes blue whales (Berman-Kowalewski et al., 2010; Calambokidis, 2012; Van Waerebeek et al., 2007), fin whales (Douglas et al., 2008; Van Waerebeek et al., 2007), sei whales (Felix & Van Waerebeek, 2005; Van Waerebeek et al., 2007), Bryde's whales (Felix & Van Waerebeek, 2005; Van Waerebeek et al., 2007), minke whales (Van Waerebeek et al., 2007), and humpback whales (Bradford & Lyman, 2015; Douglas et al., 2008; Lammers et al., 2003; Van Waerebeek et al., 2007).

Research suggests that the increasing noise in the ocean has made it difficult for whales to detect approaching vessels, which has indirectly raised the risk of vessel strike (Elvin & Taggart, 2008). For example, right whales are documented to show little overall reaction to the playback of sounds of approaching vessels, suggesting that some whales perform only a last-second flight response (Nowacek et al., 2004a). Some individuals may become habituated to low-frequency sounds from shipping and fail to respond to an approaching vessel (National Marine Fisheries Service, 2008a). Because surface activity includes feeding, breeding, and resting, whales may be engaged in this activity and not notice an approaching vessel (Silber et al., 2010). On the other hand, the lack of an acoustic cue of vessel presence can be detrimental as well. One study documented multiple cases where humpback whales struck anchored or drifting vessels; in one case a humpback whale punched a 1.5 meter hole through the hull of an anchored 22 m wooden sailboat, and another instance a humpback whale rammed a powered down 10 m fiberglass sailboat (Neilson et al., 2012). These results suggest that either the whales did not detect the vessel, or they intentionally struck it. In this study, vessel strikes to multiple cetacean species were included in the investigation; however, humpback whales were the only species that displayed this type of interaction with an unpowered vessel. Another study found that 79 percent of reported collisions between sailing vessels and cetaceans occurred when the vessels were under sail, suggesting it may be difficult for whales to detect the faint sound of sailing vessels (Ritter, 2012).

Generally, mysticetes are larger than odontocetes and are not able to maneuver as well as odontocetes to avoid vessels. In addition, mysticetes do not typically aggregate in large groups and are therefore difficult to visually detect from the water surface. Mysticetes that occur within the HSTT Study Area have varying patterns of occurrence and distribution which overlap with areas where vessel use associated with Navy training and testing activities would occur.

Odontocetes

In general, odontocetes move quickly and seem to be less vulnerable to vessel strikes than other cetaceans; however, most small whale and dolphin species have at least occasionally suffered from vessel strikes including: killer whale (Van Waerebeek et al., 2007; Visser & Fertl, 2000), short-finned and long-finned pilot whales (Aguilar et al., 2000; Van Waerebeek et al., 2007), bottlenose dolphin (Bloom & Jager, 1994; Van Waerebeek et al., 2007; Wells & Scott, 1997), white-beaked dolphin (Van Waerebeek et al., 2007), short-beaked common dolphin (Van Waerebeek et al., 2007), spinner dolphin (Camargo & Bellini, 2007; Van Waerebeek et al., 2007), striped dolphin (Van Waerebeek et al., 2007), Atlantic spotted dolphin (Van Waerebeek et al., 2007), and pygmy sperm whales (*Kogia breviceps*) (Van Waerebeek et al., 2007). Beaked whales documented in vessel strikes include: Arnoux's beaked whale (Van Waerebeek et al., 2007), Cuvier's beaked whale (Aguilar et al., 2000; Van Waerebeek et al., 2007), and several species of Mesoplodon (Van Waerebeek et al., 2007). However, evidence suggests that beaked whales may be able to hear the low-frequency sounds of large vessels and thus avoid collision (Ketten, 1998). Sperm whales may be exceptionally vulnerable to vessel strikes as they spend extended periods of time "rafting" at the surface in order to restore oxygen levels within their tissues after deep dives (Jaquet & Whitehead, 1996; Watkins et al., 1999). Overall, collision avoidance success is dependent on a marine mammal's ability to identify and locate the vessel from its radiated sound and the animal's ability to maneuver away from the vessel in time. Based on hearing capabilities and dive behavior, sperm whales may not be capable of successfully completing an escape maneuver, such as a dive, in the time available after perceiving a fast-moving vessel. This supports the suggestion that vessel speed is a critical parameter for sperm whale collision risks (Gannier & Marty, 2015).

Odontocetes that occur within the HSTT Study Area have varying patterns of occurrence and distribution which overlap with areas where vessel use associated with Navy training and testing activities would occur. Available literature suggests based on their smaller body size, maneuverability, larger group sizes, and hearing capabilities, most odontocetes (with the exception of sperm whales) are not as likely to be struck by a Navy vessel as mysticetes. When generally compared to mysticetes, odontocetes are more capable of physically avoiding a vessel strike and since some species occur in large groups, they are more easily seen when they are closer to the water surface. The Navy does not anticipate odontocete species will be struck by a vessel during Navy training and testing activities.

Pinnipeds

As noted previously in this EIS/OEIS, vessels have a potential to cause behavioral disturbance to pinnipeds. The variability observed are related to the context of the situation and by the animal's experience (Ellison et al., 2011; Richardson et al., 1995b; Southall et al., 2007). Reactions include a wide spectrum of effects 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). Physical disturbance to hauled out harbor seals caused by approaching cruise ships (Blundell & Pendleton, 2015; Jansen et al., 2015; Young et al., 2014) and by the presence of powerboats and kayaks that stopped, lingered, or moved slowly along haulout sites (Johnson & Acevedo-Gutiérrez, 2007) have been documented. Given that Navy vessels do not purposefully approach pinnipeds on land, it is unlikely that Navy training and testing involving vessels would result in disturbance to pinnipeds on land. At sea, Navy vessel presence may result in minor and insignificant changes in behavior. NMFS has previously determined that the rarity of ship strikes involving pinnipeds combined with the Navy's established standard operating procedures and mitigation measures leads to the assumption that the exposure risk of collision from surface vessels or submarines in the HSTT Study Area is small enough to be discountable (National Oceanic and Atmospheric Administration, 2015c). There has been no new science since that time which suggests a need to change that determination.

Ship strikes were not reported as a global threat to pinniped populations by Kovacs et al. (2012). Pinnipeds in general appear to suffer fewer impacts from ship strikes than do cetaceans. This may be due, at least in part, to the large amount of time they spend on land (especially when resting and breeding), and their high maneuverability in the water. Ship strikes are not a major concern for pinnipeds in general, for the threatened Guadalupe fur seal, or for the endangered Hawaiian monk seal (Antonelis et al., 2006; Marine Mammal Commission, 2002; National Marine Fisheries Service, 2007d, 2010a, 2014b). Physical disturbance and strike to pinnipeds as a result of large vessels used during Navy training and testing activities is most likely an insignificant risk to individuals and populations of pinnipeds. Reported sources of human-related injury and mortality for the U.S. West Coast from 2010 to 2014, documented 11 California sea lions, 15 harbor seals, and 2 northern elephant seals having injuries caused by boat propellers or small boat collisions (Carretta et al., 2014). Mortalities of pinnipeds (specifically harbor seals and gray seals) initially hypothesized to be injuries from ducted propellers have been found to be caused by gray seal predation, cannibalism, and infanticide (Brownlow et al., 2016).

Sea Otters

Sea otters are not expected to be at risk from vessel strike since they spend the majority of time in the water in nearshore and shallow water areas where vessels associated with training and testing in the HSTT Study Area are generally not present.

In Appendix F (Military Expended Material and Direct Strike Impact Analyses), the Navy has prepared an analysis of the potential for a Navy vessel to strike a marine mammal in the HSTT Study Area. This analysis predicts up to 1.2 strikes over the period from 2019 to 2023.

In the NMFS process for authorizing "take" pursuant to the MMPA and ESA for the Navy, NMFS determines the number of takes by species based on modeled number of exposures to those species provided as by the Navy. However, for many if not most of the Navy strike incidents, a whale/marine mammal is not identified to the species level. As a result, there are limited data for what species might have historically been struck, which marine mammal species to seek take authorization for under MMPA, and no means to provide the information required for consultation under the ESA with regard to a certainty of action since the species cannot be identified.

Given the presence, relative abundances, and behaviors, if a vessel strike were to occur in the HSTT Study Area in the future it would most likely be to any one of the large whale species regularly or seasonally inhabiting the area that include fin whale, gray whale, blue whale, humpback whale, Bryde's whale, sei whale, minke whale, and sperm whale. In terms of civilian ship strikes to large whales, humpback whales the most frequently struck species in Hawaii (Bradford & Lyman, 2015) and in Southern California the most frequently struck species are gray whales and fin whales (Carretta et al., 2016b).

The Navy and NMFS will continue ongoing discussions and exploring methodologies to better predict potential impacts on marine mammal stocks and ESA species that may result from any potential Navy vessel strike to a whale. Developments in this regard will be presented to the public when NMFS proposes regulations governing the unintentional taking of marine mammals incidental to Navy military readiness activities conducted in the HSTT Study Area from 2019 through 2023. As part of that process, NMFS will consider comments on the HSTT Draft EIS/OEIS, all discussions with Navy conducted during the development of this EIS/OEIS, and consider public input on the proposed regulations with regard to Navy vessel strikes to marine mammals in the HSTT Study Area. The preliminary impact determinations by NMFS were made available to the public for review and comment with the proposed rule in the Federal Register subsequent to the release of the Draft HSTT EIS/OEIS and the final impact determinations are presented in the sub-sections below and in the Final Rule.

In-Water Devices

In-water devices are generally smaller (several inches to 111 feet) than most Navy vessels. 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 3.0.3.3.4.1 (Vessels and In-Water Devices). Devices that could pose a collision risk to marine mammals are those operated at high speeds and are unmanned. The Navy reviewed torpedo design features and a large number of previous anti-submarine warfare torpedo exercises to assess the potential of torpedo strikes on marine mammals. The tactical software that guides U.S. Navy torpedoes is sophisticated and should not identify a marine mammal as a target. All training and testing torpedoes are recovered after being fired at targets and are reconfigured for re-use. Review of the exercise torpedo records indicates there has never been an impact on a marine mammal or other marine organism. In thousands of exercises in which torpedoes were fired or in-water devices used, there have been no recorded or reported instances of a marine species strike.

Since some in-water devices are identical to support craft, marine mammals could respond to the physical presence of the device similar to how they respond to the physical presence of a vessel.

In-water devices, such as unmanned underwater vehicles, and in-water devices towed from unmanned platforms, that move slowly through the water are highly unlikely to strike marine mammals because the mammal could easily avoid the object. In-water devices towed by manned platforms are unlikely to strike a marine mammal because of the observers on the towing platform and other standard safety measures employed when towing in-water devices. It is possible that marine mammal species that occur in areas that overlap with in-water device use associated with the Proposed Action may experience some level of physical disturbance, but it is not expected to result in more than a momentary behavioral response.

3.7.3.4.1.1 Impacts from Vessels and In-Water Devices Under Alternative 1

Section 3.0.3.3.4.1 (Vessels and In-Water Devices) provides estimates of relative vessel and in-water device use and locations throughout the Study Area. Under Alternative 1 the concentration of vessel use and the manner in which the Navy trains and tests would remain consistent with the levels of activity and types of activity undertaken in the HSTT Study Area over the last decade. Consequently, the Navy does not foresee any appreciable changes in the levels, frequency, or locations where vessels have been used over the last decade, and, therefore, the level at which physical disturbance and strikes are expected to occur is likely to remain consistent with the previous decade.

The MHI Insular false killer whale and the Hawaiian monk seal are the only marine mammal species with critical habitat located in the Study Area. Vessels and in-water devices would have no effect on MHI Insular false killer whale or monk seal critical habitat. A physical disturbance or strike to a MHI Insular false killer whale or a Hawaiian monk seal by a vessel or in-water device would be an impact on the animal (not the critical habitat) although the likelihood of a collision with a MHI Insular false killer whale or monk seal is small enough to be discountable.

Impacts from Vessels and In-Water Devices Under Alternative 1 for Training Activities

As indicated in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), most training activities involve vessel transit. Vessel strikes to marine mammals are not associated with any specific training activity but rather a limited, sporadic, and accidental result of Navy ship movement within the Study Area. Vessel movement can be widely dispersed throughout the HSTT Study Area and would be more concentrated near San Diego Bay and Pearl Harbor. Refer to Table 3.0-17 (Annual Number and Location of Activities Including Vessels) for the numbers of activities that use vessels in different locations within the HSTT Study Area.

Physical disturbance from large vessel and in-water devices would be more likely over the continental shelf portions of the Southern California Portion of the HSTT Study Area than in the Hawaii or transit corridor portions of the Study Area because of the concentration of vessel movements and in-water devices in those areas. Marine mammal species that occur over the continental shelf in the Southern California portion of the HSTT Study Area would therefore have a greater potential for impacts, and include mysticete and odontocete species described in Section 3.7.3.4.1 (Impacts from Vessels and In-Water Devices). Navy training activities involving vessels and in-water devices may occur year round; therefore, impacts from vessels, including physical disturbance and potential for strike, would depend on each species' seasonal patterns of occurrence or degree of residency in the HSTT Study Area. As previously indicated any physical disturbance from vessel transit and use of in-water devices is not expected to result in more than a momentary behavioral response.

Large vessels may occasionally be required to operate at speeds that are higher than average operating speeds when participating in certain training activities (e.g., unit-level training, carrier launch and recovery operations, etc.; for additional details see Section 3.0.3.3.4.1 (Vessels and In-Water Devices)). Periods of high vessel speed during training activities could occur in the Hawaii Range Complex and the

Southern California Range Complex. Vessels operating at higher speeds may pose a greater strike risk to marine mammals because there would be less time for the vessel crew to detect a marine mammal and maneuver to avoid a strike, and there would be less time over a given distance for the animal to react and avoid the vessel. However, the potential for greater risk may be offset by marine mammal avoidance behavior occurring at a greater distance due to the higher noise levels that are typically generated by any vessel transiting at high speed. Historically, the few vessel strikes on whales that have occurred in the HSTT Study Area (see Appendix F) have not been associated with vessels operating at higher speeds. As noted above, vessels do not travel at higher than average speeds unless required by the operational circumstances detailed in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), therefore, any increase in the risk of a strike would be minimal compared to the risk of strike from all vessel use proposed under Alternative 1.

Historical vessel use (steaming days) and ship strike data were used to calculate the probability of a direct strike during proposed training activities in the offshore portions of the HSTT Study Area, by a large Navy vessel. The Navy used at-sea days in HSTT from 2009 to 2016 and estimated potential at-sea days for the period from 2019 to 2023. The at-sea days then are used to calculate a strike rate based on the 2009–2016 reporting period. Ship at-sea time for this period totaled 33,860 days. Dividing the two reported strikes by ship at-sea day (2/33,860) results in a strike rate of 0.00006 strike per day. Estimated ship at-sea days within HSTT for the period from 2019 to 2023 is 22,663 days. The historic strike rate (0.00006 strike per day) can be multiplied by the estimated at-sea days from 2019 to 2023 to estimate the number of whale strikes that could be anticipated (0.00006 strike per day x 22,663 days). This calculation predicts up to 1.34 strikes over the period from 2019 to 2023. These values were used to determine the rate parameters to calculate a series of Poisson probabilities. A Poisson distribution is often used to describe random occurrences when the probability of an occurrence is small (e.g., count data such as cetacean sighting data, or, in this case, strike data, are often described as a Poisson or over-dispersed Poisson distribution). In modeling strikes as a Poisson process, it is assumed that the strike rate (0.00008 strikes per steaming day) applies to the future and the Poisson distribution is used to estimate the number of strikes over some future time period. The Poisson probabilities are calculated in Appendix F (Military Expended Materials and Direct Strike Impact Analyses). Results of the strike probability analysis based on a Poisson distribution indicate that there is a:

- 26 percent chance of zero strikes over the period from 2019 to 2023
- 35 percent chance of one strike over the period from 2019 to 2023
- 23 percent chance of two strikes over the period from 2019 to 2023
- 10 percent chance of three strikes over the period from 2019 to 2023

Most Navy-reported whale strikes are not identified to the species level; however, the Navy predicts that large whales have the potential to be struck by a large vessel as a result of training activities in the offshore portion of the Study Area.

The Navy will implement mitigation to avoid or reduce potential impacts from vessel and towed in-water device strikes on marine mammals throughout the Study Area (see Section 5.3.4, Physical Disturbance and Strike Stressors). 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), and requiring underway vessels and in-water devices that are towed from manned surface platforms to maneuver to maintain a specified distance from marine mammals. The Navy's mitigation measures are detailed in Chapter 5 (Mitigation), and are expected to reduce the risk of a strike to the point that vessel strikes of mysticetes are not anticipated.

As discussed in Appendix K (Geographic Mitigation Assessment), marine mammals resident to, or engaging in migratory, reproductive, and feeding behaviors within the HSTT Study Area may be impacted by vessels and in-water devices from Navy training. Impacts, including physical disturbance and strike, would be similar as what was previously discussed for odontocetes and mysticetes in the Section 3.7.3.4.1 (Impacts from Vessels and In-Water Devices). Based on the historical Navy vessel strike data presented in Appendix F (Military Expended Material and Direct Strike Impact Analyses) and a consideration of the mitigation discussed in Chapter 5 (Mitigation), the Navy does not anticipate that any cetacean would be struck by a vessel as a result of training activities in the Study Area.

Vessel transit and in-water device use may occur in portions of the MHI Insular false killer whale and Hawaiian monk seal critical habitat year-round. The constituent elements of these critical habitats would not be impacted by vessel and in-water device use during training activities within the Study Area.

The use of small crafts associated with Navy training activities within inshore waters would occur on a more regular basis than offshore vessel use and typically involve high speed (greater than 10 knots) vessel movements. The inshore waters are generally more confined waterways where mysticetes and offshore odontocete species do not typically occur. As stated in Section 3.7.3.4.1 (Impacts from Vessels and In-Water Devices), odontocetes known to occur within inshore waters in San Diego, such as bottlenose dolphins, are not as susceptible to vessel strikes as compared to mysticetes. In addition, no vessel strikes of marine mammals have been reported due to Navy inshore training activities. Therefore, the Navy does not anticipate that it will strike odontocetes as a result training activities in inshore waters.

Vessel movements related to training activities occur near marine mammals only on an incidental basis. Navy mitigation measures described in Chapter 5 (Mitigation) will help the Navy avoid interactions with marine mammals, which would further reduce any potential physical disturbance and direct strike impacts from vessels. Long-term consequences on populations of marine mammals are not expected to result from vessel movement and in-water device use associated with the proposed training activities.

The use of vessels during training activities as described under Alternative 1 could result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA. The Navy has consulted with NMFS regarding authorization of those takes as pursuant to section 101(a)(5)(A) of the MMPA in that regard. In addition, the use of in-water devices during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA. Based on the resulting probabilities presented in Appendix F, the cumulative low history of Navy vessel strikes from 2009 to 2016, and the decrease in strike incidents (zero since 2009) by the Navy since introduction of the Marine Species Awareness Training and adaptation of additional mitigation measures since 2009, the Navy does not anticipate vessel strikes to marine mammals within the HSTT Study Area during training activities. As cautionary acknowledgments that some probability of ship strike, although low, could occur over a five-year authorization, and that there are no historical data specific to large unmanned surface vehicles upon which risk of strike can be precisely assessed, the Navy is electing to request a small number of takes to select large whale stocks from vessel strikes for the HSTT Study Area.

Pursuant to the ESA, the use of vessels and in-water devices during training activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Vessels and In-Water Devices Under Alternative 1 for Testing Activities

As indicated in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), testing activities primarily involve large vessel movement. However, the number of activities that include large vessel movement for testing is comparatively lower than the number of training activities. In addition, testing often occurs jointly with a training event, so it is likely that the testing activity would be conducted from a training vessel. Vessel movement and use in conjunction with testing activities could be widely dispersed throughout the Study Area, but would be concentrated near naval ports, piers, range complexes, and especially in the vicinity of Pearl Harbor, Hawaii and San Diego Bay, California.

Propulsion testing, which sometimes includes ships operating at speeds in excess of 30 knots, and use of large high speed unmanned surface vessels occur infrequently but may pose a higher strike risk because of the high speeds at which the vessels need to achieve in order to complete the testing activity. These activities could occur in the Hawaii Range Complex and Southern California Range Complex. However, there are just a few of these events proposed per year, so the increased risk is nominal compared to all vessel use proposed under Alternative 1.

Also as discussed in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), testing activities involving the use of in-water devices would occur in the HSTT Study Area at any time of year. Unmanned surface vehicle use would occur within both the Hawaii and Southern California portions of the HSTT Study Area. Large unmanned surface vehicles are an emerging technology area. Within the timeframe covered by this analysis, the Navy anticipates that testing of large unmanned surface vehicles in the HSTT Study Area would occur up to approximately 300 at-sea days per year. During some testing of large unmanned surface vehicles, the platforms would be manned by testing personnel who would serve as Lookouts and would have the ability to override autonomous navigation; however, other testing would occur while the platform is unmanned. Autonomous marine mammal detection technologies are being investigated, but it is assumed that these technologies may not be available for large unmanned surface vehicle testing in the timeframe covered by this analysis. Unlike for manned naval vessels, there are no historical at-sea hours or strike data upon which a large unmanned surface vehicle strike analysis can be based. The method presented above for naval vessels, therefore, is followed to assess the risk of strike due to the addition of large unmanned surface vehicle at-sea days. Following the method presented above, an additional 300 at-sea days annually are added to the strike risk to account for large unmanned surface vehicles. This is a small increase in risk compared to the risk based on historical data for manned vessels; however, actual additional risk is assumed to be greater because of the lack of both lookouts and implementation of procedural mitigation. Still, this increased risk would be limited because large unmanned surface vehicle at-sea days are a small portion (less than 7 percent) of overall vessel predicted at-sea days for 2019–2023, large unmanned surface vehicles would be substantially smaller than most naval vessels, and a portion of large unmanned surface vehicle tests would include lookouts who could implement avoidance mitigation.

The Navy will implement mitigation to avoid or reduce potential impacts from vessel and in-water device strikes on marine mammals throughout the Study Area (see Section 5.3.4, Physical Disturbance and Strike Stressors). 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), and requiring underway vessels and in-water devices that are towed from manned surface platforms to maneuver to maintain a specified distance from marine mammals. Some vessels that operate autonomously have embedded sensors that aid in their avoidance of large objects, which may help avoid physical disturbance and strike of marine mammals from certain unmanned vehicles, even though the mitigation zone will not be visually observed. The Navy's mitigation measures are detailed in Chapter 5 (Mitigation), and are expected to reduce the risk of a strike to marine mammals in general.

As discussed in Appendix K (Geographic Mitigation Assessment), marine mammals resident to, or engaging in migratory, reproductive, and feeding behaviors within the HSTT Study Area may be impacted by vessels and in-water devices from Navy testing. Impacts, including physical disturbance and strike, would be similar to what was previously discussed for odontocetes and mysticetes in the Section 3.7.3.4.1 (Impacts from Vessels and In-Water Devices). Based on the historical Navy vessel strike data presented in Appendix F (Military Expended Material and Direct Strike Impact Analyses) and a consideration of the mitigation discussed in Chapter 5 (Mitigation), the Navy does not anticipate that any cetacean would be struck by a vessel as a result of testing activities in the Study Area.

Vessel transit and in-water device use may occur in portions of the MHI Insular false killer whale and Hawaiian monk seal critical habitats year-round. The constituent elements of these critical habitats would not be impacted by vessel and in-water device use during testing activities within the Study Area.

Vessel transit and in-water device use related to testing activities occur near marine mammals only on an incidental basis. Navy mitigation measures described in Chapter 5 (Mitigation) will help the Navy avoid interactions with marine mammals which would further reduce any potential physical disturbance and direct strike impacts on marine mammals from vessel transit. Long-term consequences to populations of marine mammals are not expected to result from vessel transit and in-water device use associated with the proposed testing activities.

The use of vessels during testing activities as described under Alternative 1 could result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA. The Navy has consulted with NMFS regarding authorization of those takes as pursuant to section 101(a)(5)(A) of the MMPA. In addition, the use of in-water devices during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA. Based on the resulting probabilities presented in Appendix F, the cumulative low history of Navy vessel strikes from 2009–2016, and the decrease in strike incidents (zero since 2009) by the Navy since introduction of the Marine Species Awareness Training and adaptation of additional mitigation measures since 2009, the Navy does not anticipate vessel strikes to marine mammals within the HSTT Study Area during testing activities. As cautionary acknowledgments that some probability of ship strike, although low, could occur over a five-year authorization, and that there are no historical data specific to large unmanned surface vehicles upon which risk of strike can be precisely assessed, the Navy is electing to request a small number of takes to select large whale stocks from vessel strikes for the HSTT Study Area.

Pursuant to the ESA, the use of vessels and in-water devices during testing activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.7.3.4.1.2 Impacts from Vessels and In-Water Devices Under Alternative 2

Section 3.0.3.3.4.1 (Vessels and In-Water Devices) provides locations and number of activities that include vessels and in-water device use throughout the Study Area. Under Alternative 2, the locations of training activities that include vessels and in-water devices would be the same as what is proposed under Alternative 1. However, the number of activities proposed under Alternative 2 varies from what is proposed under Alternative 1 and is discussed in detail below.

Impacts from Vessels and In-Water Devices Under Alternative 2 for Training Activities

As shown in Table 3.0-15 (Annual Number and Location of Activities Including Vessels), training activities that involve vessel movement under Alternative 2 would only increase by a small fraction of one percent over what is proposed under Alternative 1. Even with this nominal increase in activity level, Navy training activities would remain consistent with the levels of activity and types activities undertaken in the HSTT Study Area over the last decade. Consequently, the level which physical disturbance and vessel strikes are expected to occur is likely to remain consistent with the previous decade. Similarly, Table 3.0-17 (Annual Number and Location of Activities Including In-Water Devices) shows the use of in-water devices associated with training activities under Alternative 2 would increase by approximately 16 percent over what is proposed for training activities under Alternative 1. This level of increased of use in-water devices would not appreciably change the potential for physical disturbance or strike of a marine mammal. Therefore, impacts from training activities involving vessels and in-water devices under Alternative 2 would be similar to Alternative 1 and the analyses presented in Section 3.7.3.4.1.1 (Impacts from Vessels and In-Water Devices Under Alternative 1) for training activities are applicable to training activities under Alternative 2.

The use of vessels during testing activities as described under Alternative 2 could result in the unintentional taking of marine mammals incidental to those activities, as defined by the MMPA, but the use of in-water devices during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of vessels and in-water devices during training activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals.

Impacts from Vessels and In-Water Devices Under Alternative 2 for Testing Activities

As shown on Table 3.0-15 (Annual Number and Location of Activities Including Vessels), testing activities that involve vessel movement under Alternative 2 are proposed to increase by a fraction of one percent as compared to Alternative 1. As previously indicated, the number of testing activities that involve vessels are much lower than the number of training activities. Furthermore, testing activities may be conducted simultaneously with a training event, using a training vessel. The proposed increase in vessel use from testing activities under Alternative 2 would still be consistent with the levels of activity and types activities undertaken in the HSTT Study Area over the last decade. Therefore, the level which physical disturbance and strikes are expected to occur would remain consistent with the previous decade.

In addition, as shown on Table 3.0-17 (Annual Number and Location of Activities Including In-Water Devices), in-water device use under Alternative 2 would increase by approximately four times over what is proposed annually for testing activities under Alternative 1 for the Southern California portion of the HSTT Study Area; there is no change in the proposed number for the Hawaii or Transit Corridor portions of the Study Area. This level of increased use of in-water devices would increase the potential for physical disturbance or strike of a marine mammals in the Southern California portion of the HSTT Study Area.

As discussed in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), testing activities involving the use of in-water devices would occur in the HSTT Study Area at any time of year. Unmanned surface vehicle use would occur within both the Southern California and Hawaii portions of the HSTT Study Area.

The Navy will implement mitigation to avoid or reduce potential impacts from vessel and in-water device strikes on marine mammals throughout the Study Area (see Section 5.3.4, Physical Disturbance and Strike Stressors). 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), and requiring underway vessels and in-water devices that are towed from manned surface platforms to maneuver to maintain a specified distance from marine mammals. The Navy's mitigation measures are detailed in Chapter 5 (Mitigation), and are expected to reduce the risk of a strike to the point that vessel strikes of mysticetes are not anticipated.

As discussed in Appendix K, marine mammals resident to, or engaging in migratory, reproductive, and feeding behaviors within the HSTT Study Area may be impacted by vessels and in-water devices from Navy testing. Impacts, including physical disturbance and strike, would be similar as what was previously discussed for odontocetes and mysticetes in the Section 3.7.3.4.1 (Impacts from Vessels and In-Water Devices).

Vessel transit and in-water device use may occur in portions of the MHI Insular false killer whale and Hawaiian monk seal critical habitats year-round. The constituent elements of these critical habitats would not be impacted by vessel and in water device use during testing activities within the Study Area.

Vessel transit and in-water device uses related to testing activities occur near marine mammals only on an incidental basis. Navy mitigation measures described in Chapter 5 (Mitigation) include several provisions to avoid approaching will help the Navy avoid interactions with marine mammals which would further reduce any potential physical disturbance and direct strike impacts on marine mammals from vessel transits and in-water devices. Long-term consequences to individuals or populations of marine mammals are not expected to result from vessel transit and in-water device use associated with the proposed testing activities under Alternative 2.

The use of vessels during testing activities as described under Alternative 2 could result in the unintentional taking of marine mammals incidental to those activities, as defined by the MMPA. The use of in-water devices during testing activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of vessels and in-water devices during testing activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals.

3.7.3.4.1.3 Impacts from Vessels and In-Water Devices Under the No Action Alternative

Impacts from Vessels and In-Water Devices Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Physical disturbance and strike stressors (e.g., vessels and in-water devices) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.7.3.4.2 Impacts from Aircraft and Aerial Targets

Impacts from aircraft and aerial targets are not applicable to marine mammals because they do not occur in airborne environments and will not be analyzed further in this section. Refer to the Impacts from Military Expended Materials section (Section 3.7.3.4.3) for impacts from target fragments and the Acoustic Stressors section (Section 3.7.3.1) for potential disturbance from aircraft.

3.7.3.4.3 Impacts from Military Expended Materials

This section analyzes the strike potential to marine mammals from the following categories of military expended materials: (1) all sizes of non-explosive practice munitions, (2) fragments from high-explosive munitions, (3) expendable targets and target fragments, and (4) expended materials other than munitions; such as sonobuoys, expended bathythermographs, and torpedo accessories. For a discussion of the types of activities that use military expended materials see Appendix B (Activity Stressor Matrices) and for how many events would occur under each alternative, see Section 3.0.3.3.4.2 (Military Expended Materials). As described in Appendix F (Military Expended Material and Direct Strike Impact Analyses), for physical disturbance and strike stressors as it relates to marine mammals, impacts from fragments from high-explosive munitions are included in the analysis presented in Section 3.7.3.2 (Explosive Stressors), and are not considered further in this section. Potential impacts from military expended materials as ingestion stressors to marine mammals are discussed in Section 3.7.3.6.1 (Impacts from Military Expended Materials–Munitions) and Section 3.7.3.6.2 (Impacts from Military Expended Materials Other than Munitions).

The primary concern is the potential for a marine mammal to be hit with a military expended material at or near the water's surface, which could result in injury or death. While disturbance or strike from an item falling through the water column is possible, it is not very likely because the objects generally sink slowly through the water based on the weights of expended materials and can be avoided by most marine mammals. Therefore, the discussion of military expended materials strikes will focus on the potential of a strike at the surface of the water.

While no strike from military expended materials has ever been reported or recorded, the possibility of a strike still exists. Therefore, the potential for marine mammals to be struck by military expended materials was evaluated using statistical probability modeling to estimate potential direct strike exposures to a marine mammal under a worst-case scenario. Specific details of the modeling approach including model selection and calculation methods are presented in Appendix F (Military Expended Material and Direct Strike Impact Analyses).

To estimate potential direct strike exposures, a worst-case scenario was calculated using the marine mammal with the highest average seasonal density in areas with the highest military expended material expenditures in the Hawaii and Southern California portions of the HSTT Study Area. This is considered a worst-case scenario because, as described below, probability calculations of a single military item hitting an animal assumes all activities would be conducted during the season with the highest marine mammal densities and that all marine mammals have the equal densities. For estimates of expended materials in all areas, see Section 3.0.3.3.4.2 (Military Expended Materials).

For all the remaining marine mammal species with lesser densities, this highest likelihood approach would overestimate the likelihood or probability of a strike. Direct strike exposures of marine mammal species protected under the ESA are estimated separately from non-ESA species. Because the ESA has specific standards for understanding the likelihood of impacts on each endangered species, estimates were made for all endangered marine mammals found in the areas where the highest levels of military expended materials would be expended. In this way, the appropriate ESA conclusions could be based on the highest estimated probabilities of a strike for those species.

Input values include munitions data (frequency, footprint and type), size of the training or testing area, marine mammal density data and size of the animal. To estimate the potential of military expended materials to strike a marine mammal, the impact area of all military expended materials was totaled over one year in the area with highest combined amounts of military expended materials for each of the two action alternatives.

The analysis of the potential for a marine mammal strike is influenced by the following assumptions:

- The model is two-dimensional and assumes that all marine mammals 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 & Block, 2009).
- The model also does not take into account the fact that most of the projectiles fired during training and testing activities are fired at targets, and most projectiles hit those targets, so only a very small portion of those would hit the water with their maximum velocity and force.
- The model assumes the animal is stationary and does not account for any movement of the marine mammal or any potential avoidance of the training or testing activity.

The potential of fragments from high explosive munitions or expended material other than munitions to strike a marine mammal is likely lower than for the worst-case scenario calculated above because those events happen with much lower frequency. Fragments may include metallic fragments from the exploded target, as well as from the exploded munitions.

Marine mammal species that occur in the Study Area may be exposed to the risk of military expended material strike, with the exception of the sea otters in the shallow nearshore waters around San Nicolas Island where these stressors would not occur. The MHI Insular false killer whale and the Hawaiian monk seal critical habitats would not be impacted by military expended materials as a physical disturbance and strike stressor.

The model output (Appendix F, Military Expended Material and Direct Strike Impact Analyses) provides a reasonably high level of certainty that marine mammals would not be struck by military expended materials. These results are summarized in the following sections discussing impacts under each alternative.

As discussed in Appendix K, there are marine mammals resident to, or engaging in migratory, reproductive, and feeding behaviors within certain areas in the HSTT Study Area. Marine mammals in those areas may be affected by military expended materials from Navy training and testing. Physical disturbance from military expended materials may result in a momentary behavioral response and but would not result in resident marine mammals avoiding these areas or result in the abandonment of behaviors in these areas.

3.7.3.4.3.1 Impacts from Military Expended Materials Under Alternative 1

<u>Impacts from Military Expended Materials Under Alternative 1 for Training Activities</u>

Training activities that involve military expended materials under Alternative 1 would occur throughout the Study Area, with the exception of in shallow nearshore areas, San Diego Bay, and Pearl Harbor.

The model results presented in Appendix F (Military Expended Material and Direct Strike Impact Analyses) estimate representative marine mammal exposures from direct strike during training activities. Based on a worst case scenario, the results indicate with a reasonable level of certainty that marine mammals would not be struck by non-explosive practice munitions, targets, and expended materials other than munitions. Direct strike exposure estimates range from 0.00 blue whales to 0.15 short-beaked common dolphin in the HSTT Study Area over the course of a year. In addition, direct strike exposure estimates are essentially zero (maximum exposure estimate of less than 0.01) for all other marine mammal species in the HSTT Study Area. As discussed above, this does not take into account assumptions that likely overestimate potential impacts and the behavior of marine mammals (e.g., short-beaked common dolphins generally occur in large pods and are relatively easy to spot), which would reduce the risk of a strike.

The use of military expended material during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended material during training activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Military Expended Materials Under Alternative 1 for Testing Activities

Testing activities that involve military expended materials under Alternative 1 would throughout the Study Area, with the exception of in shallow nearshore areas, San Diego Bay, and Pearl Harbor.

The model results presented in Appendix F (Military Expended Material and Direct Strike Impact Analyses) estimate representative marine mammal exposures from direct strike during testing activities. Based on a worst case scenario, the results indicate with a reasonable level of certainty that marine mammals would not be struck by explosive and non-explosive practice munitions, targets, and expended materials other than munitions. Direct strike exposure estimates range from 0.00 blue whales to 0.10 short-beaked common dolphin in the HSTT Study Area over the course of a year. In addition, direct strike exposure estimates are essentially zero (maximum exposure estimate of less than 0.01) for all other marine mammal species in the HSTT Study Area. As discussed above, this does not take into account assumptions that likely overestimate potential impacts and the behavior of marine mammals (e.g., short-beaked common dolphins generally occur in large pods and are relatively easy to spot), which would reduce the risk of a strike.

The use of military expended material during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended material during testing activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.7.3.4.3.2 Impacts from Military Expended Materials Under Alternative 2

Impacts from Military Expended Materials Under Alternative 2 for Training Activities

Training activities under Alternative 2 would involve the same amount of non-explosive practice munitions and fragments from high-explosive munitions for all locations in the Study Area as what is proposed under Alternative 1. As shown in Section 3.0.3.3.4.2 (Military Expended Materials), there would be an increase in the use of sonobuoys and other military materials during training under Alternative 2 within the Study Area.

The model results presented in Appendix F (Military Expended Material and Direct Strike Impact Analyses) estimate representative marine mammal exposures from direct strike during training activities. Based on a worst case scenario, the military expended materials strike exposure estimates range from 0.00 blue whales to approximately a 0.84 short-beaked common dolphin in the HSTT Study Area over the course of a year. Exposure of 0.03 to an endangered Guadalupe fur seal is also predicted. Direct strike exposure estimates are essentially zero (maximum exposure estimate of less than 0.01) for all other marine mammal species in the HSTT Study Area. As discussed above, this does not take into account assumptions that likely overestimate potential impacts and the behavior of marine mammals (e.g., short-beaked common dolphins generally occur in large pods and are relatively easy to spot), which would reduce the risk of a strike.

The use of military expended material during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended material during training activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals.

Impacts from Military Expended Materials Under Alternative 2 for Testing Activities

Testing activities under Alternative 2 would involve the same amount of non-explosive practice munitions and fragments from high-explosive munitions for all locations in the Study Area as what is proposed under Alternative 1. As shown in Section 3.0.3.3.4.2 (Military Expended Materials), there would be a minor increase in the use of sonobuoys and decelerator/parachutes during testing under Alternative 2 within the Study Area.

Probability analysis results in Appendix F indicates that the minor increase in the amount of expended materials proposed under Alternative 2 does not result in any substantial increase in the risk that a marine mammal would be struck by a military expended material. Therefore, the associated impacts on marine mammals are expected to be similar to Alternative 1 and the analyses presented in Section 3.7.3.4.3.1 (Impacts from Military Expended Materials under Alternative 1) for testing activities would be applicable to military expended materials associated with testing activities under Alternative 2.

The use of military expended material during testing activities, as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended material during testing activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals.

3.7.3.4.3.3 Impacts from Military Expended Materials Under the No Action Alternative

Impacts from Military Expended Materials Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Physical disturbance and strike stressors (e.g., military expended materials) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.7.3.4.4 Impacts from Seafloor Devices

For a discussion of the types of activities that use seafloor devices see Appendix B (Activity Stressor Matrices); for a discussion on where they are used and how many events would occur under each alternative, see Section 3.0.3.3.4.3 (Seafloor Devices); and for a discussion of seafloor devices as a secondary stressor (unrelated to strike stressors), see Section 3.7.3.7.1 (Impacts on Habitat). These include items placed on, dropped on or moved along the seafloor such as mine shapes, anchor blocks, anchors, bottom-placed devices, and bottom-crawling unmanned underwater vehicles. The likelihood of any marine mammal species encountering seafloor devices is considered low because these items are either stationary or move very slowly along the bottom. In the unlikely event that a marine mammal is in the vicinity of a seafloor device, the stationary or very slowly moving devices would not be expected to physically disturb or alter natural behaviors of marine mammals. The only seafloor device used during training and testing activities that has the potential to strike a marine mammal at or near the surface is an aircraft deployed mine shape, which is used during aerial mine laying activities. These devices are identical to non-explosive practice bombs; therefore, the analysis of the potential impacts from those devices are covered in Section 3.7.3.4.3 (Impacts from Military Expended Materials) and are not further analyzed in this section.

As discussed in Appendix K (Geographic Mitigation Assessment), there are marine mammals resident to, or engaging in migratory, reproductive, and feeding behaviors within certain areas in the HSTT Study Area. Marine mammals in those areas may be affected by seafloor devices from Navy training and testing. Physical disturbance from seafloor devices may result in a momentary behavioral response and but would not result in resident marine mammals avoiding these areas or result in the abandonment of behaviors in these areas.

3.7.3.4.4.1 Impacts from Seafloor Devices Under Alternative 1

<u>Impacts from Seafloor Devices Under Alternative 1 for Training Activities</u>

Training activities that use seafloor devices under Alternative 1 would occur throughout the HSTT Study Area including within Pearl Harbor in Hawaii and San Diego Bay in California. Based on the analysis in Section 3.7.3.4.3.1 (Impacts from Military Expended Materials under Alternative 1) for training activities, there is a reasonable level of certainty that there would be no physical disturbance or strike resulting from use of seafloor devices.

Training activities in Hawaii that use seafloor devices (in particular anchors) could occur within MHI Insular false killer whale or Hawaiian monk seal critical habitat. For the MHI Insular false killer whale and as described in 3.7.2.2.7.1 (Status and Management), although there is overlap with the waters from the 45 m depth contour to the 3,200 m depth contour around the main Hawaiian Islands from Niihau east to Hawaii forming the critical habitat for the species, there are no identified essential features that could be affected by the use of seafloor devices. For the Hawaiian monk seal and as presented in detail in Section 3.7.2.2.9.1 (Status and Management), the essential feature of the critical habitat that could be affected by seafloor devices is identified as marine areas from 0 to 500 m in depth preferred by juvenile and adult monk seals for foraging (see National Oceanic and Atmospheric Administration (2015d)). Previously for Navy actions including use of seafloor devices in the HSTT Study Area, NMFS determined those actions, "… are not likely to result in the destruction or adverse modification of critical habitat that has been designated" (National Marine Fisheries Service, 2015f). Consistent with these previous findings for the same actions and stressor, seafloor devices will not affect Hawaiian monk seal critical habitat.

The use of seafloor devices during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat as a physical strike or disturbance stressor, but may effect Hawaiian monk seal critical habitat as a secondary stressor; for further discussion see Section 3.7.3.7.1 (Impacts on Habitat). Alternative 1 may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Seafloor Devices Under Alternative 1 for Testing Activities

Testing activities that use seafloor devices under Alternative 1 would occur throughout the HSTT Study Area including within Pearl Harbor in Hawaii and San Diego Bay in California. Based on the analysis in Section 3.7.3.4.3.1 (Impacts from Military Expended Materials under Alternative 1) for training activities, there is a reasonable level of certainty that there would be no physical disturbance or strike resulting from use of seafloor devices.

Testing activities in Hawaii that use seafloor devices (in particular anchors) could occur within the MHI Insular false killer whale or the Hawaiian monk seal critical habitat since they may forage on the seafloor. For the MHI Insular false killer whale and as described in 3.7.2.2.7.1 (Status and Management), although there is overlap with the waters from the 45 m depth contour to the 3,200 m depth contour around the main Hawaiian Islands from Niihau east to Hawaii forming the critical habitat for the species, there are no identified essential features that could be affected by the use of seafloor devices. For the Hawaiian monk seal and as presented in detail in Section 3.7.2.2.9.1 (Status and Management), the essential feature of the critical habitat that could be affected by seafloor devices is identified as marine areas from 0 to 500 m in depth preferred by juvenile and adult monk seals for foraging (see National Oceanic and Atmospheric Administration (2015d)). Consistent with these previous findings for the same actions and stressor, seafloor devices will not affect Hawaiian monk seal critical habitat (National Marine Fisheries Service, 2015f).

The use of seafloor devices during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat as a physical strike or disturbance stressor, but may effect Hawaiian monk seal critical habitat as a secondary stressor; for further discussion see Section 3.7.3.7.1 (Impacts on Habitat). Alternative 1 may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.7.3.4.4.2 Impacts from Seafloor Devices Under Alternative 2

Impacts from Seafloor Devices Under Alternative 2 for Training Activities

As presented in Section 3.0.3.3.4.3 (Seafloor Devices; Table 3.0-26) the locations and annual number of training activities that involve seafloor devices are the same for Alternatives 1 and 2 within the Hawaii portion of the HSTT Study Area and within the Southern California portion of the HSTT Study Area they decrease by an insignificant number. Therefore, the impacts on marine mammals for the use of seafloor devices under Alternative 2 are expected to be the similar to Alternative 1 and as presented in Section 3.7.3.4.4.1 (Impacts from Seafloor Devices under Alternative 1).

The use of seafloor devices during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat as a physical strike or disturbance stressor, but may effect Hawaiian monk seal critical habitat as a secondary stressor; for further discussion see Section 3.7.3.7.1 (Impacts on Habitat). Alternative 2 may affect ESA-listed marine mammals.

Impacts from Seafloor Devices Under Alternative 2 for Testing Activities

As presented in Section 3.0.3.3.4.3 (Seafloor Devices; Table 3.0-26) the locations and annual number of testing activities that involve seafloor devices are the same for Alternatives 1 and 2 within the Hawaii portion of the HSTT Study Area and within the Southern California portion of the HSTT Study Area they increase by an insignificant number. Therefore, the impacts on marine mammals for the use of seafloor devices under Alternative 2 are expected to be the similar to Alternative 1 and as presented in Section 3.7.3.4.4.1 (Impacts from Seafloor Devices under Alternative 1).

The use of seafloor devices during testing activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat as a physical strike or disturbance stressor, but may effect Hawaiian monk seal critical habitat as a secondary stressor; for further discussion see Section 3.7.3.7.1 (Impacts on Habitat). Alternative 2 may affect ESA-listed marine mammals.

3.7.3.4.4.3 Impacts from Seafloor Devices Under the No Action Alternative

Impacts from Seafloor Devices Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Physical disturbance and strike stressors (e.g., seafloor devices) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.7.3.4.5 Impacts from Pile Driving

Impact pile driving and vibratory pile removal would occur during training for the construction of an Elevated Causeway System using pile driving and vibratory pile removal, are described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.3-2, was considered as a potential physical disturbance stressor. Section 3.0.3.3.1.3 (Pile Driving) provides additional details on pile driving and noise levels measured from similar construction activity. Construction of an Elevated Causeway System, and therefore pile driving, would not occur during testing activities in the HSTT Study Area.

Impacts to marine mammals from pile driving activities as an acoustic stressor are addressed Section 3.7.3.1.4 (Impacts from Pile Driving). This section addresses the physical presence of the resulting temporary pier as part of the Elevated Causeway System as a potential physical disturbance stressor. The size of the pier would be no greater than 1,520 feet long, consisting of 119 supporting piles, on the beach and out into shallow coastal waters of the Silver Strand Training Complex or Marine Corps Base Camp Pendleton. Given the nearshore locations for this training activity and the temporary nature of the structures, it is not likely that marine mammals would experience physical disturbance from the presence of the temporary pier structure. Furthermore, it is not likely that a marine mammal would be struck by a piling during installation. Therefore, the Navy has determined that the Elevated Causeway System training activity would not result in physical disturbance impacts above those described in Section 3.7.3.1.4 (Impacts from Pile Driving) and are not considered further in this section.

3.7.3.5 Entanglement Stressors

This section analyzes the potential for entanglement of marine mammals as the result of proposed training and testing activities within the Study Area. This analysis includes the potential impacts from three types of military expended materials: (1) wires and cables, (2) decelerators/parachutes, and (3) biodegradable polymers. The number and location of training and testing events that involve the use of items that may pose an entanglement risk are provided in Section 3.0.3.3.5 (Entanglement Stressors). General discussion of impacts can also be found in Section 3.0.3.6.4 (Conceptual Framework for Assessing Effects from Entanglement).

These materials could be encountered by and if encountered, may have the potential to entangle marine mammals in the HSTT Study Area at the surface, in the water column, or along the seafloor. Since potential impacts depend on how a marine mammal encounters and reacts to items that pose an entanglement risk, the following subsections discuss research relevant to specific groups or species. Risk factors such as animal size, sensory capabilities and foraging methods are also considered in the potential risk for entanglement. Most entanglements discussed are attributable to marine mammal encounters with fishing gear or other non-military materials that float or are suspended at the surface (National Marine Fisheries Service, 2018). Entanglement events are difficult to detect from land or from a boat as they may occur at considerable distances from shore and typically take place underwater. Smaller entangled animals are inherently less likely to be detected than larger ones, but larger animals may subsequently swim off while still entangled, towing lines or fishing gear behind them. The likelihood of witnessing an entanglement event is therefore typically low (Benjamins et al., 2014). However, the properties and size of these military expended materials, as described in Section 3.0.3.3.5 (Entanglement Stressors) and Section 3.0.3.6.4 (Conceptual Framework for Assessing Effects from Entanglement), makes entanglement unlikely.

Since there has never been a reported or recorded instance of a marine mammal entangled in military expended materials, the Navy considered the available literature and reports on entanglement (Bradford & Lyman, 2015; Carretta et al., 2013b; Carretta et al., 2016b; Carretta et al., 2017b; National Marine Fisheries Service, 2018; National Oceanic and Atmospheric Administration Marine Debris Program, 2014a). These reports indicate that active and derelict fishing gear is the predominant cause of entanglement. The reason for this, and the ways that fishing gear may be different from military expended materials are as follows: (1) fishing gear is most often used in areas of high productivity where whales may congregate and feed; whereas military expended materials are generally used in broad, diverse, open ocean areas and expenditures are not concentrated; (2) fishing gear is designed to trap/entangle marine life and are made with a high breaking strength to withstand prolonged use in the ocean environment; military expended materials are not designed to persist in the ocean environment for long periods of time and are not designed to entangle or capture marine life; and (3) fishing gear and ropes are designed to float or be suspended in the water column for long periods of time; where most military expended materials sink immediately and rapidly.

As discussed in Appendix K, there are marine mammals resident to, or engaging in migratory, reproductive, and feeding behaviors within certain areas in the HSTT Study Area. Marine mammals in those areas may be affected by entanglements stressors from Navy training and testing. Entanglement stressors may result in a momentary behavioral response and but would not result in resident marine mammals avoiding these areas or result in the abandonment of behaviors in these areas.

Mysticetes

Mysticete species with documented entanglement reports include blue whale, Bryde's whales, bowhead whales, fin whales, gray whales, humpback whales, minke whales, North Atlantic right whales, and sei whales (Baulch & Perry, 2014; Baulch & Simmonds, 2015; Bradford & Lyman, 2015; Carretta et al., 2013b; Carretta et al., 2016b; Carretta et al., 2017a; Laist, 1997; National Oceanic and Atmospheric Administration Marine Debris Program, 2014a; Neilson et al., 2009; Saez et al., 2013). In Southeast Alaska, the estimated percentage of humpback whales that have been non-lethally entangled in their lifetime ranges from 52 to 78 percent (Neilson et al., 2009) and approximately 19 percent for gray whales feeding off Sakhalin Island, Russia (Bradford et al., 2009). Cassoff et al. (2011) report that in the western North Atlantic, mortality due to entanglement has slowed the recovery of some populations of mysticetes. Included in their analysis of 21 entanglement related mortalities were minke, Bryde's, North Atlantic right whale, and humpback whales.

Based on feeding adaptations for mysticetes, oral entanglement may pose one of the greatest threats to survival, due to impaired foraging and possibly loss of function of the hydrostatic seal (formed when upper and lower lips come together and keep the mouth closed) requiring the whale to expend energy to actively keep the mouth closed during swimming (Cassoff et al., 2011). Impaired foraging could lead to deterioration of health, making the animal more susceptible to disease, or eventual starvation over a long period of time. Compounding the issue, trailing lengths of rope or line may become wrapped around the animal's appendages as it struggles to free itself (Kozuck, 2003), limiting the animal's mobility. This reduced mobility can also reduce foraging success or even limit the animal's ability to surface. Notably, the single acute cause of entanglement mortalities has been associated with drowning from multiple body parts being entangled (Cassoff et al., 2011).

Common sources of entanglements for mysticetes include fishing gear lines and net fragments attached through the mouth or around the tail and flippers (National Oceanic and Atmospheric Administration, 2017a; National Oceanic and Atmospheric Administration Marine Debris Program, 2014a). Rope diameter and breaking strengths may also determine an animal's ability to break free from entanglement. Increased rope strength has been found to be positively correlated with injury severity in right whales, but not for humpback whales (Knowlton et al., 2016). Minke whales were also found entangled in lower breaking strength ropes (10.47 kilonewtons [2,617 lb.-force]) than both humpback and right whales (17.13 and 19.30 kilonewtons [3,851 and 4,339 lb.-force], respectively) (Knowlton et al., 2016). These are significantly greater than the breaking strength of torpedo guidance wires (maximum 40.4 lb.-force) as described in Section 3.0.3.3.5.1, Wires and Cables. Entanglement would be more likely for materials with similar physical properties as those described above.

In the Hawaiian Islands between 2006 and 2011, there were 74 entanglements reported (National Marine Fisheries Service, 2008b, 2010b, 2010d, 2011b, 2011g). The identified sources of entanglement were fishing gear; there are no known cases of marine mammals entangled in Navy expended materials.

From 1998-2005, based on observer records, five fin whales (CA/OR/WA stock), 12 humpback whales (Eastern North Pacific stock), and six sperm whales (CA/OR/WA stock) were either seriously injured or killed in fisheries due to entanglement off the mainland West Coast of the U.S. (National Marine Fisheries Service, 2011c). Subsequent examination of the data indicated that from 1982 to Feb 2012 in the California, Oregon, Washington areas inhabited by stocks of large whales there were 279 reported whale entanglements (Saez et al., 2012). In 2015-2016, there were 71 cases of entangled whales reported off the coasts of Washington, Oregon, and California (National Oceanic and Atmospheric Administration, 2017a), which the range area for the stocks of whales present in the Southern California portion of the HSTT Study Area. For the identified sources of entanglement, none included Navy expended materials. Identified mysticete species entangled off the U.S. West Coast in 2015 and 2016 included humpback, gray, blue, and fin whales with a total of 133 entanglements in the 2-year period (National Oceanic and Atmospheric Administration, 2017a).

Military expended material is expected to sink to the ocean floor. It is possible that marine mammals could encounter these items within the water column as they sink to the bottom. Less buoyant items that sink faster are not as likely to become entangled with a marine mammal compared to more buoyant materials that would sink slower. Mysticetes that occupy the water column or skim feed along the water surface would have to encounter a military expended material at the same time and location it is either expended or as it sinks. Mysticete species that feed near or at the bottom in the areas where activities make use of military expended materials could encounter items that have already sunk and therefore do not have to be present at the precise time when items are expended. Seasonally present when migrating through the Southern California portion of the HSTT Study area, the gray whale is the only mysticete occurring in the Study Area that regularly feeds at the seafloor, but it does so nearshore in relatively shallow water soft sediment seafloor area where these military expended material entanglement stressors are less likely to be present. Additionally, gray whales rarely attempt to feed when migrating through Southern California and so are not expected to interact with the seafloor in the HSTT Study Area.

Odontocetes

Odontocete species with documented records of marine debris entanglement, excluding active fishing gear, are the bottlenose dolphin, Dall's porpoise, harbor porpoise, killer whale, Pacific white-sided dolphin, sperm whale, spinner dolphin, and spotted dolphin (Bradford & Lyman, 2015; Carretta et al., 2016b; National Oceanic and Atmospheric Administration, 2017a; National Oceanic and Atmospheric Administration Marine Debris Program, 2014a). Bottlenose dolphins are the most commonly entangled odontocete with most entanglements involving monofilament line, net fragments, and rope attached to appendages (National Oceanic and Atmospheric Administration Marine Debris Program, 2014a). Heezen (1957) reported two confirmed instances of sperm whales entangled in the slack lengths of telegraph cable near cable repair sites along the seafloor. These sperm whales likely became entangled while feeding along the bottom, as the cables were most often found wrapped around the jaw.

Pinnipeds

Entanglement is considered a serious threat to several populations of pinnipeds (Kovacs et al. 2012); approximately 66-67 percent of pinniped species have been recorded as entangled (Kuhn et al., 2015; Reeves et al., 2013). Younger pinnipeds appear to be more prone to entanglement than adults (Hofmeyr et al., 2006; Page et al., 2004). A young pup may become so entangled that its body becomes constricted by the material as it grows. Death may occur by strangulation or severing of the arteries (Derraik, 2002).

In the Hawaii portion of the HSTT Study Area, Hawaiian monk seals have one of the highest documented entanglement rates of any pinniped species (National Marine Fisheries Service, 2011a, 2016j; Pacific

Islands Fisheries Science Center, 2010). This most often includes derelict fishing gear including nets, fish line, and fishhooks but marine debris are also a large concern; there are no known cases of Hawaiian monk seal being entangled in military expended material. While pinnipeds in the Study Area feed primarily in the water column, Hawaiian monk seal, which occur in Hawaii Range Complex portion of the Study Area, are opportunistic feeders and also forage on the seafloor. It is unlikely that Hawaiian monk seal would be impacted by entanglement stressors if encountered on the seafloor.

It is not known if, in addition to Hawaiian monk seal, other phocid seals in the Study Area (Northern elephant and harbor seals) have similar entanglement occurrence. Fur seals (such as those otariid present in the Southern California portion of the Study Area; Northern fur seal, and Guadalupe fur seal) and California sea lion appear to be attracted to floating debris and consequently suffer a high rate of entanglement in derelict fishing lines and nets (Carretta et al., 2016b; Derraik, 2002) than other pinniped species. Their unique habit of rolling on the surface of the water leads to complex entanglement.

Sea Otters

Sea Otters at San Nicolas Island would not encounter entanglement stressors because the shallow water near shore area they inhabit is not an area where entanglement stressors would occur as a result of Navy training and testing activities evaluated in this analysis.

3.7.3.5.1 Impacts from Wires and Cables

For a discussion of the types of activities that use wires and cables see Appendix B (Activity Stressor Matrices), and for where they are used and how many events would occur under each alternative, see Section 3.0.3.3.5.1 (Wires and Cables). The likelihood of a marine mammal encountering and becoming entangled in a fiber optic cable depends on several factors. The amount of time that the cable is in the same vicinity as a marine mammal can increase the likelihood of it posing an entanglement risk. Although a portion may be recovered, some fiber optic cables used during Navy training and testing associated with remotely operated mine neutralization activities would be expended. The length of the expended fiber optic cable would vary (up to about 3,000 m) depending on the activity. The behavior and feeding strategy of a species can determine whether they may encounter items on the seafloor, where cables will be available for longer periods of time. There is potential for those species that feed on the seafloor to encounter cables and potentially become entangled, however the relatively few cables being expended within the HSTT Study Area limits the potential for encounters. Deployed tactical fiber will break if looped beyond its bend radius (3.4 mm), or exceeds its tensile strength (12 lb.). If the fiber becomes looped around a marine animal, it will not tighten unless it is under tension. Such an event would be unlikely based on its method of deployment and its resistance to looping after it is expended. The tactical fibers are often designed with controlled buoyancy to minimize the fiber's effect on vehicle movement. The tactical fiber would be suspended within the water column during the activity, and then be expended and sink to the seafloor (effective sink rate of 1.45 cm/second (Raytheon Company, 2015)) where it would be susceptible to abrasion and burial by sedimentation. Since the cable will only be within the water column during the activity and while it sinks, the likelihood of a marine mammal encountering and becoming entangled within the water column is extremely low.

For certain testing activities (see Appendix A - Energy and Intelligence, Surveillance, and Reconnaissance/Information Operations Sensor Systems), long-length (up to approximately 60 mi.) fiber optic cables would be deployed in the water column in the Southern California portion of the HSTT Study Area. These long-length fiber optic cables are slightly negatively buoyant, have a breaking strength of approximately 100 lb. or less, and are designed to resist coiling or the forming of loops when unspooled. The fiber optic cable would be temporarily deployed in the water column between moored points at depths of approximately 600 to 850 ft. The fiber optic cable used in this test would be typically be deployed for durations of approximately one week while researchers monitor transmissions through the fiber optic cable, although deployments could extend to one month. As with fiber optic cables used during training events, the likelihood of a marine mammal encountering and becoming entangled within the water column during the temporary deployment is extremely low. Additionally, most marine mammals do not dive to the depth of deployment and those that may generally spend a small portion of their time at that depth (sperm whales – 14 percent, beaked whales 7 percent, *Kogia* spp., Fraser's dolphin, and short-finned pilot whales all approximately less than 1 percent; see U.S. Department of the Navy (2017c). Each fixed mooring points associated with the deployment of fiber optic cables would consist of a mooring cable suspended from a float that is anchored to the seafloor or a surface ship. While the mooring cable at these fixed points would be of higher strength, they would also be recovered at the end of the activity and given that short duration, the likelihood of a marine mammal encountering and becoming entangled with a mooring cable is extremely low.

Similar to fiber optic cables discussed above, guidance wires may pose an entanglement threat to marine mammals either in the water column or after the wire has settled to the seafloor. The likelihood of a marine mammal encountering and becoming entangled in a guidance wire depends on several factors. With the exception of a chance encounter with the guidance wire while it is sinking to the seafloor (at an estimated rate of 0.24 meter per second), it is most likely that a marine mammal would only encounter a guidance wire once it had settled on the seafloor. Since the guidance wire will only be within the water column during the activity and while it sinks, the likelihood of a marine mammal encountering and becoming entangled within the water column is extremely low. Guidance wires have a relatively low tensile breaking strength (maximum of 40.4 lb.) and can be broken by hand (Swope & McDonald, 2013), contrasting with the rope or lines associated with commercial fishing towed gear (trawls), stationary gear (traps), or entanglement gear (gillnets) that use lines with substantially higher (up to 500 to 2,000 lb.) breaking strength as their "weak links." However, the breaking strength is somewhat higher than the monofilament used in the body of most commercial gillnets (typically 31 lb. or less). The resistance to looping and coiling suggest that torpedo guidance wire does not have a high entanglement potential compared to other entanglement hazards (Swope & McDonald, 2013). In addition, based on degradation times, the guide wires would break down within one to two years and therefore no longer pose an entanglement risk. The length of the guidance wires vary, as described in Section 3.0.3.3.5.1 (Wires and Cables), but greater lengths increase the likelihood that a marine mammal could become entangled. The behavior and feeding strategy of a species can determine whether they may encounter items on the seafloor, where guidance wires will most likely be available. There is potential for those species that feed on the seafloor to encounter guidance wires and potentially become entangled; however, the relatively few guidance wires being expended within the HSTT Study Area limits the potential for encounters.

Sonobuoy wires are used to attach the surface antenna and float unit with the subsurface hydrophone assembly unit of a sonobuoy. They are slightly longer than fiber optic cables (up to 1,500 ft.) and have a tensile breaking strength of 40 lb. Operationally, sonobuoys remain suspended in the water column for up to 30 hours, which would increase the likelihood that a marine mammal could encounter a sonobuoy wire either while it is suspended or as it sinks. Marine mammals could encounter the sonobuoy wires while in operation in the water column and species that feed on the bottom could encounter the wires after they have sunk to the seafloor.

Marine mammal species that occur within the HSTT Study Area were evaluated based on the likelihood of encountering these items. Mysticete, odontocete, and pinniped species that occur where these training and testing activities take place and forage on the bottom could encounter these items once they settle to the seafloor.

An evaluation of potential environmental impacts related to guidance wire left at sea where torpedo tests are conducted by the Navy suggests there is an extremely low entanglement potential for marine animals found within these range areas (Swope & McDonald, 2013). The chance that an individual animal would encounter expended cables or wires is most likely low based on (1) the sparse distribution of both the cables and wires expended throughout the Study Area, (2) the fact that the wires and cables will sink upon release, and (3) the relatively few marine mammals that are likely to feed on the bottom in the deeper waters where these would be expended. It is very unlikely that an animal would get entangled even if it encountered a cable or wire while it was sinking or upon settling to the seafloor. A marine mammal would have to swim through loops, become twisted within the cable or wire to become entangled, or in the case of mysticetes, get the cable or wire stuck in their baleen to become entangled, and given the properties of the expended wires (low breaking strength, sinking rates, and reluctance to coiling or looping) this seems unlikely. As indicated in the report by Neilson et al. (2009), a large percentage of humpback whales have been non-lethally entangled in their lifetime, suggesting some degree of ability to become disentangled. So while an animal may initially become entangled in a cable or wire while either swimming in the water column or feeding on the bottom, they may become free in situations where the item breaks or if it is only loosely attached and the animal is able to maneuver to free itself from permanent entanglement. As a result, no long-term impacts would occur. Based on the estimated concentration of expended cables and wires, impacts from cables or wires are extremely unlikely to occur. In fact, current data suggests that torpedo guidance wires do not present a physical hazard in the marine environment (Swope & McDonald, 2013).

3.7.3.5.1.1 Impacts from Wires and Cables Under Alternative 1

Impacts from Wires and Cables Under Alternative 1 for Training Activities

Training activities under Alternative 1 would expend wires and cables within the Study Area. Refer to Section 3.0.3.3.5.1 (Wires and Cables) for the number of events and locations where cables and wires would be expended. Under Alternative 1 and as presented in Table 3.0-28, the majority of wires and cables would be expended within the Southern California portion of the HSTT Study Area but there would be no areas of concentrated use in either Hawaii or Southern California. Based on the low concentration of expended wires and cables combined with their physical characteristics, the Navy anticipates that no marine mammals would become entangled.

As discussed in Appendix K (Geographic Mitigation Assessment), blue whale feeding areas, gray whale migration routes, humpback whale reproduction areas, and 11 odontocete species small and resident population areas within or overlapping the HSTT Study Area have been identified (Baird et al., 2015a; Calambokidis et al., 2015). Any potential overlap of Navy activities involving use of cables and wires with the particular species in these areas is unlikely to result in incidental take under the MMPA or ESA. Based on the low concentration of expended wires and cables combined with their physical characteristics, the Navy anticipates that no marine mammals would become entangled.

The use of wires and cables during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of wires and cables during training activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Wires and Cables Under Alternative 1 for Testing Activities

Testing activities under Alternative 1 would expend wires and cables within the Study Area. Refer to Section 3.0.3.3.5.1 (Wires and Cables) for the number of events and locations where cables and wires would be expended. Under Alternative 1 and as presented in Table 3.0-29, the majority of wires and cables would be expended within the Southern California portion of the HSTT Study Area but there would be no areas of concentrated use in either Hawaii or Southern California. Based on the low concentration of expended wires and cables combined with their physical characteristics, the Navy anticipates that no marine mammals would become entangled.

As discussed in Appendix K, blue whale feeding areas, gray whale migration routes, humpback whale reproduction areas, and 11 odontocete species small and resident population areas within or overlapping the HSTT Study Area have been identified (Baird et al., 2015a; Calambokidis et al., 2015). Any potential overlap of Navy activities involving use of cables and wires with the particular species in these areas is unlikely to result in incidental take under the MMPA or ESA. Based on the low concentration of expended wires and cables combined with their physical characteristics, the Navy anticipates that no marine mammals would become entangled.

The use of wires and cables during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of wires and cables during testing activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.7.3.5.1.2 Impacts from Wires and Cables Under Alternative 2

Impacts from Wires and Cables Under Alternative 2 for Training Activities

As presented in 3.0.3.3.5.1 (Wires and Cables) the locations and annual number of training activities that involve wires and cables are the virtually the same for Alternatives 1 and 2 within the Hawaii portion of the HSTT Study Area and within the Southern California portion of the HSTT Study Area they increase by an insignificant number (approximately three percent). Therefore, the impacts on marine mammals for the use of wires and cables under Alternative 2 are expected to be the similar to Alternative 1 and as presented in Section 3.7.3.5.1.1 (Impacts from Wires and Cables under Alternative 1).

The use of wires and cables during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of wires and cables during training activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals.

Impacts from Wires and Cables Under Alternative 2 for Testing Activities

As presented in 3.0.3.3.5.1 (Wires and Cables) the locations and annual number of testing activities that involve wires and cables are the virtually the same for Alternatives 1 and 2 within the HSTT Study Area and given they increase by an insignificant number (less than approximately two percent). Therefore, the impacts on marine mammals for the use of wires and cables under Alternative 2 are expected to be the similar to Alternative 1 and as presented in Section 3.7.3.5.1.1 (Impacts from Wires and Cables under Alternative 1).

The use of wires and cables during testing activities, as described under Alternative 2, will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of wires and cables during testing activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals.

3.7.3.5.1.3 Impacts from Wires and Cables Under the No Action Alternative

Impacts from Wires and Cables Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Entanglement stressors (e.g., cables and wires) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.7.3.5.2 Impacts from Decelerators/Parachutes

Refer to Section 3.0.3.3.5.2 (Decelerators/Parachutes) for the number of training and testing events that involve the use of decelerators/parachutes and the geographic areas where they would be expended. Training and testing activities that introduce decelerators/parachutes into the water column can occur anywhere in the HSTT Study Area.

As described in Section 3.0.3.3.5.2 (Decelerators/Parachutes), decelerators/parachutes used during the proposed activities are classified into four different categories based on size: small, medium, large, and extra-large. The vast majority of expended decelerators/parachutes are small (18 in.), are cruciform shaped, and are used with sonobuoys. Illumination flares and targets use medium-sized decelerators/parachutes, up to 19 ft. in diameter. Both small- and medium-sized decelerators/parachutes are made of cloth and nylon, many with weights attached to their short attachment lines to speed their sinking. Upon water impact, the decelerator/parachute assembly may remain at the surface for 5–15 seconds before the decelerator/parachute and its housing sink to the seafloor, where it becomes flattened (Environmental Sciences Group, 2005).

Aerial targets use large (between 30 and 50 ft. in diameter) and extra-large (80 ft. in diameter) decelerators/parachutes. Large and extra-large decelerators/parachutes are also made of cloth and nylon, with suspensions lines of varying lengths (large: 40 to 70 ft. in length [with up to 28 lines per decelerator/parachute]; extra-large: 82 ft. in length [with up to 64 lines per decelerator/parachute]). Some aerial targets also use a small drag parachute (6 ft. in diameter) to slow their forward momentum prior to deploying the larger primary decelerator/parachute. Large and extra-large decelerators/parachutes do not have weights attached to them and may remain at the surface or suspended in the water column longer than small and medium decelerators/parachutes prior to settling on the seafloor.

Entanglement of a marine mammal in a decelerator/parachute assembly at the surface or within the water column would be unlikely, since the decelerator/parachute would have to land directly on an animal, or an animal would have to swim into it and become entangled within the cords or fabric panel before it sinks or while it is sinking through the water column. Once on the seafloor, if bottom currents are present, the small cruciform fabric panels may temporarily billow and pose an entanglement threat to marine animals with bottom-feeding habits; however, the probability of a marine mammal encountering a decelerator/parachute assembly on the seafloor and accidental entanglement in the small cruciform fabric panel or short suspension cords is unlikely.

The chance that an individual animal would encounter expended decelerators/parachutes is low based on the sparse distribution of the decelerators/parachutes expended throughout the Study Area, the fact that assemblies are designed to sink upon release, and the relatively few marine mammals that feed on the bottom. Based on the information summarized above within the introduction to Section 3.7.3.5 (Entanglement Stressors), mysticetes found within the Study Area are not expected to encounter decelerators/parachutes on the seafloor because, with the exception of gray whales during seasonal migrations through the Study Area, and potentially humpback whales, they do not feed there. The majority of decelerators/parachutes expended will occur in deep ocean areas, which are not the shallow water locations where gray whales and humpback whales feed on the bottom. The majority of decelerators/parachutes used are relatively small (approximately 18 in. in diameter) and are not likely to be an entanglement hazard to marine mammals. Furthermore, there has never been any recorded or reported instance of a marine mammal becoming entangled in a decelerator/parachute.

The possibility of odontocetes and pinnipeds becoming entangled exists for species that feed on the bottom in areas where decelerators/parachutes have been expended. This is unlikely because decelerators/parachutes are primarily used in events that occur in waters far out to sea. Species that are known to feed on the bottom in deep water as well as the mid-water column include beaked whales, sperm whales, dwarf/pygmy sperm whales, and elephant seals. Even for these species, because the majority of decelerators are relatively small and there has never been any recorded or reported instance of a marine mammal becoming entangled in a decelerator/parachute, they are not likely to be an entanglement hazard.

3.7.3.5.2.1 Impacts from Decelerators/Parachutes Under Alternative 1

<u>Impacts from Decelerators/Parachutes Under Alternative 1 for Training Activities</u>

Training activities under Alternative 1 would expend decelerators/parachutes within the HSTT Study Area, in both the Hawaii Range Complex and Southern California Range Complex. Section 3.0.3.3.5.2 (Decelerators/Parachutes; Table 3.0-25) shows the number of decelerators/parachutes expended during training under Alternative 1. The Southern California Range Complex would have the greatest concentration of expended decelerators/parachutes, where one decelerator/parachute would be expended per 4.5 square nautical miles (NM^2), if evenly distributed throughout the area. Based on the low concentration of expended decelerator/parachutes, the Navy anticipates that no marine mammals would become entangled in decelerators/parachutes.

The use of decelerators/parachutes during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of decelerators/parachutes during training activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Decelerators/Parachutes Under Alternative 1 for Testing Activities

Testing activities under Alternative 1 would expend decelerators/parachutes within the HSTT Study Area, in both the Hawaii Range Complex and Southern California Range Complex. Section 3.0.3.3.5.2 (Decelerators/Parachutes; Table 3.0-25) shows the number of decelerators/parachutes expended during testing under Alternative 1. The Southern California Range Complex would have the greatest concentration of expended decelerators/parachutes, where one decelerator/parachute would be expended per 5.5 NM^2, if evenly distributed throughout the area. Based on the low concentration of expended decelerator/parachutes, the Navy anticipates that no marine mammals would become entangled in decelerators/parachutes.

The use of decelerators/parachutes during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of decelerators/parachutes during testing activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.7.3.5.2.2 Impacts from Decelerators/Parachutes Under Alternative 2

Impacts from Decelerators/Parachutes Under Alternative 2 for Training Activities

Training activities under Alternative 2 would expend decelerators/parachutes within the HSTT Study Area, in both the Hawaii Range Complex and Southern California Range Complex. Section 3.0.3.3.5.2 (Decelerators/Parachutes; Table 3.0-25) shows the number of decelerators/parachutes expended during training under Alternative 2. Except for an increase in the number of small decelerators/parachutes in the SOCAL portion of the HSTT Study Area), the number of the number of decelerators/parachutes expended is the same as under Alternative 1. The Southern California Range Complex would have the greatest concentration of expended decelerators/parachutes, where one decelerator/parachute would be expended per 4.4 NM^2, if evenly distributed throughout the area. The Navy anticipates that no marine mammals would become entangled in decelerators/parachutes. The use of decelerators/parachutes during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of decelerators/parachutes during training activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals.

Impacts from Decelerators/Parachutes Under Alternative 2 for Testing Activities

Testing activities under Alternative 2 would expend decelerators/parachutes within the HSTT Study Area, in both the Hawaii Range Complex and Southern California Range Complex. Section 3.0.3.3.5.2 (Decelerators/Parachutes; Table 3.0-25) shows the number of decelerators/parachutes expended during testing under Alternative 2. The Southern California Range Complex would have the greatest concentration of expended decelerators/parachutes, where one decelerator/parachute would be expended per 5.6 NM^2, if evenly distributed throughout the area. Based on the low concentration of expended decelerator/parachutes, the Navy anticipates that no marine mammals would become entangled in decelerators/parachutes.

The use of decelerators/parachutes during testing activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of decelerators/parachutes during testing activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals.

3.7.3.5.2.3 Impacts from Decelerators/Parachutes Under the No Action Alternative

Impacts from Decelerators/Parachutes Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Entanglement stressors (e.g., decelerators/parachutes) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.7.3.5.3 Impacts from Biodegradable Polymer

For a discussion of the types of activities that use biodegradable polymers see Appendix B (Activity Stressor Matrices) and for a discussion on where they are used and how many activities would occur under each alternative, see Section 3.0.3.3.5.3 (Biodegradable Polymer). Navy activities that involve vessel stopping payloads systems include the development of the biodegradable polymer and would be associated with testing activities in the HSTT Study Area. As indicated by its name, vessel entanglement systems that make use of biodegradable polymers are designed to entangle the propellers of in-water vessels, which would significantly slow and potentially stop the advance of the vessel. A biodegradable polymer is polymer that degrades to smaller compounds as a result of microorganisms and enzymes. The biodegradable polymers that the Navy uses are designed to temporarily interact with the propeller(s) of a target craft rendering it ineffective. Some of the polymer constituents would dissolve within two hours of immersion. Based on the constituents of the biodegradable polymer the Navy proposes to use, it is anticipated that the material will breakdown into small pieces within a few days to weeks. This will breakdown further and dissolve into the water column within weeks to a few months. Degradation and dispersal timelines are influenced by water temperature, currents, and other oceanographic features. Overall, the longer the polymer remains in the water, the weaker it becomes, making it more brittle and likely to break. At the end of dispersion, the remaining materials are generally separated fibers with lengths on the order of 54 micrometers. 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.

3.7.3.5.3.1 Impacts from Biodegradable Polymer Under Alternative 1

Impacts from Biodegradable Polymer Under Alternative 1 for Training Activities

Biodegradable polymers would not be used during training activities associated with the Proposed Action.

Impacts from Biodegradable Polymer Under Alternative 1 for Testing Activities

Testing activities under Alternative 1 that use biodegradable polymers could be conducted throughout the HSTT Study Area. The number of testing activities involving biodegradable polymers conducted in the HSTT Study Area is relatively low, as shown in Table 3.0-30 (Annual Activities Including

Biodegradable Polymers). Based on the small levels of activity, the concentration of these items being expended throughout the HSTT Study Area is likewise considered low and the Navy does not anticipate that any marine mammals would become entangled with biodegradable polymers. Testing activities that expend biodegradable polymers may occur within MHI Insular false killer whale critical habitat (see description of the critical habitat in Section 3.7.2.2.7.1, Status and Management), but would have no effect on the identified features of that critical habitat. Testing activities that expend biodegradable polymers would not occur within monk seal critical habitat.

The use of biodegradable polymers during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of biodegradable polymer during testing activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS and the USFWS as required by section 7(a)(2) of the ESA.

3.7.3.5.3.2 Impacts from Biodegradable Polymer Under Alternative 2

<u>Impacts from Biodegradable Polymer Under Alternative 2 for Training Activities</u>

Biodegradable polymers would not be used during training activities associated with the Proposed Action.

<u>Impacts from Biodegradable Polymer Under Alternative 2 for Testing Activities</u>

The location and number of testing activities that expend biodegradable polymer and associated impacts are identical under Alternatives 1 and 2. Refer to Section 3.7.3.5.3.2 (Impacts from Biodegradable Polymer Under Alternative 1).

The use of biodegradable polymers during testing activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of biodegradable polymer during testing activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals.

3.7.3.5.3.3 Impacts from Biodegradable Polymer Under the No Action Alternative

<u>Impacts from Biodegradable Polymer Under the No Action Alternative for Training and Testing Activities</u>

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Biodegradable polymer is not a part of ongoing Navy activities in the Study Area and this entanglement stressor would not be introduced into the marine environment under the No Action Alternative. Therefore, no change in baseline conditions of the existing environment would occur.

3.7.3.6 Ingestion Stressors

This section analyzes the potential impacts of the various types of ingestion stressors used during training and testing activities within the Study Area. This analysis includes the potential impacts from the following types of military expended materials: non-explosive practice munitions (small- and medium-caliber), fragments from high-explosives, fragments from targets, chaff, flare casings (including plastic end caps and pistons), decelerators/parachutes, and biodegradable polymers. For a discussion on the types of activities that use these materials see Appendix B (Activity Stressor Matrices), and for discussion on where they are used and how many activities would occur under each alternative, see Section 3.0.3.3.6 (Ingestion Stressors). General discussion of impacts can also be found in Section 3.0.3.6.5 (Conceptual Framework for Assessing Effects from Ingestion).

The distribution and density of expended items plays a central role in the likelihood of impact on marine mammals. The Navy conducts training and testing activities throughout the Study Area and those that result in expended materials that could be ingested are widely distributed and low in density. The majority of material expended during Navy training and testing would likely penetrate into the seafloor and not be accessible to most marine mammals. Since potential impacts depend on where these items are expended and how a marine mammal feeds, the following subsections discuss important information for specific groups or species.

There have been no general surveys to investigate marine debris on the seafloor in Hawaii. Watters et al. (2010) conducted a visual survey of the seafloor that included a portion of the Navy's Southern California range complex as part of a 15-year quantitative assessment of marine debris on the seafloor off the California coast. Watters et al. (2010) found plastic was the most abundant material and along with recreational monofilament fishing line dominate in the debris (note that U.S. Navy vessels have a zero-plastic trash discharge policy and return all plastic waste to appropriate disposition sites on shore). There was only one item found that was potentially "military" in origin. Keller et al. (2010) characterized the composition and abundance of man-made marine debris during Groundfish Bottom Trawl Surveys in 2007 and 2008 along the U.S. West Coast at 1,347 randomly selected stations. This including some sample sites that were within the Southern California portion of the HSTT Study Area and within that subset, some that included historically used post-WWII dump sites. The evidence that post-WWII dump sites were sampled was indicated by items recovered that included equipment described as "helmets," "gas masks," "uniforms," and other miscellaneous and diverse items including "plastic," "file cabinets," and "buckets" that are not (since approximately the 1970s) disposed of at sea and are not military expended material associated with the activities of the HSTT Proposed Action. For this reason, the characterization of "military debris" in Keller et al. (2010) has little if any relevance to current Navy training and testing procedures or present-day standard Navy conduct that includes (among others) not discharging any plastics.

As discussed in Appendix K, there are marine mammals resident to, or engaging in migratory, reproductive, and feeding behaviors within certain areas in the HSTT Study Area. Marine mammals in those areas may be affected by ingestions stressors from Navy training and testing. Ingestion stressors result in a momentary behavioral response and but would not result in resident marine mammals avoiding these areas or result in the abandonment of behaviors in these areas.

Mysticetes

Species that feed at the surface or in the water column include blue, fin, Bryde's, minke, and sei whales. While humpback whales feed predominantly by lunging through the water after krill and fish, there are data confirming that humpback whales display bottom-feeding behaviors in the Atlantic in areas of high concentrations of preferred prey, the northern sand lance (*Ammodytes dubius*) (Hain et al., 1995; Ware et al., 2014). Gray whales are also seasonally present when migrating through the Study Area. Gray whales and humpback whales are the only mysticetes likely to occur in the Study Area that feed at the seafloor, but do so in relatively shallow water and soft sediment areas where ingestion stressors are less likely to be present (fewer activities take place in shallow water and expended materials are more likely to bury in soft sediment and be less accessible). Since baleen whales feed by filtering large amounts of water, they like encounter and consume plastic debris at higher rates than other marine animals (National Oceanic and Atmospheric Administration Marine Debris Program, 2014b).

Baleen whales are believed to routinely encounter microplastics within the marine environment based on concentrations of these items and baleen whale feeding behaviors (Andrady, 2011). In a comprehensive review of documented ingestion of debris by marine mammals by Laist (1997), there are two species of mysticetes (bowhead and minke whale) with records of having ingested debris items that included plastic sheeting and a polythene bag. This effort was followed up by a comparative summary of the earlier review with additional information and the number of mysticete species with documented records of ingestion increased to seven species, including right whales, pygmy right whales, gray whales, and four rorqual species (Bergmann et al., 2015). Information compiled by Williams et al. (2011) listed humpback whale, fin whale, minke whale as three species of mysticetes known to have ingested debris including items the authors characterized as fishing gear, polyethylene bag, plastic sheeting, plastic bags, rope, and general debris. Besseling et al. (2015) documented the first occurrence of microplastics in the intestines of a humpback whale.

Feeding behaviors of mysticete species suggest that potential encounters with ingestion stressors would only occur when the items are on the water surface at the same time and locations where animals are skim feeding or while engulfing prey in the water column as items sink to the bottom. Bottom-feeding humpback whales and gray whales may also encounter ingestion stressors that have already sunk.

Odontocetes

Walker and Coe (1990) provided data on the stomach contents from of 16 species of odontocetes, some of which occur or had stranded in Southern California waters with evidence of debris ingestion. Of the odontocete species occurring in the HSTT Study Area, only sperm whale, Baird's beaked whale, and Cuvier's beaked whale had ingested items (likely incidentally) that do not float and are thus indicative of foraging at the seafloor. While there was no evidence of ingestion by the other species in the study, this does not eliminate the possibility that those other species, as well as species not part of the study, may also ingest items encountered on the seafloor. Beaked whales use suction feeding to ingest benthic prey and may incidentally ingest other items (MacLeod et al., 2003). Both sperm whales and beaked whales are known to incidentally ingest foreign objects while foraging; however, this does not always result in negative consequences to health or vitality (Laist, 1997; Walker & Coe, 1990). While this incidental ingestion has led to sperm whale mortality in some cases (Jacobsen et al., 2010), Whitehead (2003) suggested the scale to which this affects sperm whale populations was not substantial. Sperm whales are recorded as having ingested fishing net scraps, rope, wood, and plastic debris such as plastic bags and items from the seafloor (Walker & Coe, 1990; Whitehead, 2003).

Weaned juveniles, who are investigating multiple types of prey items, may be particularly vulnerable to ingesting non-food items, as found in a study of juvenile harbor porpoise (Baird & Hooker, 2000). A male pygmy sperm whale reportedly died from blockage of two stomach compartments by hard plastic, and a Blainville's beaked whale (*Mesoplodon densirostris*) washed ashore in Brazil with a ball of plastic thread in its stomach (Derraik, 2002). In a comprehensive review of documented ingestion of debris by marine mammals, odontocetes had the most ingestion records with 21 species represented (Laist, 1997). A follow-up to this review revealed an increase in odontocete ingestion of marine debris. Bergmann et al. (2015) reported 40 odontocete species have documented records of ingestion.

Pinnipeds

Pinnipeds are opportunistic foragers, primarily feeding within the water column, but may also forage on the seafloor. In a review of documented ingestion of debris by marine animals, 36 percent of seal species were found to have ingested plastics (Kuhn et al., 2015). Laist (1997) reported ingestion of Styrofoam cups by northern elephant seals and Steller sea lions, and Bravo Rebolledo et al. (2013) reported plastics in the diet of harbor seals. There is a possibility of prey species transferring ingested debris to predators that consume then, as demonstrated by Eriksson and Burton (2003) for fur seals. This suggests that the risk of marine mammals ingesting debris may also depend on the likelihood that prey items would ingest debris. Even though some pinniped species feed on the bottom, such as harbor seals, it is unlikely that pinnipeds would encounter and incidentally or mistakenly consume military expended items associated with proposed Navy training and testing activities.

Sea Otters

Sea Otters would not encounter ingestion stressors because the shallow water area they inhabit (at San Nicolas Island in the Southern California portion of the HSTT Study Area) is not a proposed location for activities involving ingestion stressors.

3.7.3.6.1 Impacts from Military Expended Materials – Munitions

Different types of explosive and non-explosive practice munitions are expended at sea during training and testing activities. This section analyzes the potential for marine mammals to ingest non explosive practice munitions and fragments from high explosive munitions.

Types of non-explosive practice munitions generally include projectiles, missiles, and bombs. Of these, only small- or medium-caliber projectiles would be small enough for a marine mammal to ingest. Small- and medium-caliber projectiles include all sizes up to and including 2.25 in. in diameter. These solid metal materials would quickly move through the water column and settle to the seafloor. Ingestion of non-explosive practice munitions is not expected to occur in the water column because munitions sink quickly. Instead, they are most likely to be encountered by species that forage on the bottom.

Types of high explosive munitions that can result in fragments include demolition charges, projectiles, missiles, and bombs. Fragments would result from fractures in the munitions casing and would vary in size depending on the size of the net explosive weight and munitions type; however, typical sizes of fragments are unknown. These solid metal materials would quickly move through the water column and settle to the seafloor; therefore, ingestion is not expected by most species. Fragments are primarily encountered by species that forage on the bottom.

Based on the information summarized above in Section 3.7.3.6 (Ingestion Stressors), mysticetes found within the Study Area, with the exception of bottom-feeding gray whales and potentially humpback whales, are not expected to encounter non-explosive practice munitions on the seafloor. Ingestion of non-explosive practice munitions by odontocetes is likely to be incidental, with items being potentially consumed along with bottom-dwelling prey. Although incidental ingestion of non-explosive practice munitions by pinnipeds is not likely based on records of ingestion from stranded animals, it is possible because they feed on the seafloor.

3.7.3.6.1.1 Impacts from Military Expended Materials –Munitions Under Alternative 1

Impacts from Military Expended Materials –Munitions Under Alternative 1 for Training Activities

Non-Explosive Practice Munitions and Fragments from High-Explosive Munitions

As discussed in Section 3.0.3.3.6 (Ingestion Stressors), training activities involving non-explosive practice munitions and high-explosive munitions fragments would occur within the HSTT Study Area.

The amount of non-explosive practice munitions and high-explosive munitions fragments that an individual animal would encounter is generally low based on the patchy distribution of both the projectiles and an animal's feeding habits. In addition, an animal would not likely ingest every projectile it encountered. Furthermore, an animal may attempt to ingest a projectile and then reject it when it realizes it is not a food item. Even ingestion of certain items (hooks), if they do not become embedded in tissue, do not end up resulting in injury or mortality to the individual (Wells et al., 2008; West, 2016). Therefore, potential impacts of non-explosive practice munitions or fragments ingestion would be limited to the unlikely event in which a marine mammal might suffer a negative response from ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. The Navy considers the likelihood of this occurring to be very low.

The use of military expended materials - munitions during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended materials - munitions during training activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS and the USFWS as required by section 7(a)(2) of the ESA.

Impacts from Military Expended Materials – Munitions Under Alternative 1 for Testing Activities

Non-Explosive Practice Munitions and Fragments from High-Explosive Munitions

As discussed in Section 3.0.3.3.6 (Ingestion Stressors), testing activities involving non-explosive practice munitions and high-explosive munitions fragments would occur within the HSTT Study Area.

The amount of non-explosive practice munitions and high-explosive munitions fragments that an individual animal would encounter is generally low based on the patchy distribution of both the projectiles and an animal's feeding habitat. In addition, an animal would not likely ingest every projectile it encountered. Furthermore, an animal may attempt to ingest a projectile and then reject it when it realizes it is not a food item. Even ingestion of certain items (hooks), if they do not become embedded in tissue, do not end up resulting in injury or mortality to the individual (Wells et al., 2008). Therefore, potential impacts of non-explosive practice munitions or fragments ingestion would be limited to the unlikely event in which a marine mammal might suffer a negative response from ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system.

The use of military expended materials - munitions during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended materials - munitions during testing activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS and the USFWS as required by section 7(a)(2) of the ESA.

3.7.3.6.1.2 Impacts from Military Expended Materials –Munitions Under Alternative 2

Impacts from Military Expended Materials –Munitions Under Alternative 2 for Training Activities

Non-Explosive Practice Munitions and Fragments from High-Explosive Munitions

Training activities that expend non-explosive practice munitions and high-explosive munitions fragments under Alternative 2 would be identical to what is proposed under Alternative 1. The analysis presented in Section 3.7.3.6.1.1 (Impacts from Military Expended Materials – Munitions under Alternative 1) for training activities would also apply to training activities proposed for Alternative 2.

The use of military expended materials - munitions during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended materials - munitions during training activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals.

Impacts from Military Expended Materials –Munitions Under Alternative 2 for Testing Activities

Non-Explosive Practice Munitions and Fragments from High-Explosive Munitions

Testing activities that expend non-explosive practice munitions and high-explosive munitions fragments under Alternative 2 would be identical to what is proposed under Alternative 1. The analysis presented in Section 3.7.3.6.1.1 (Impacts from Military Expended Materials – Munitions under Alternative 1) for testing activities would also apply to testing activities proposed for Alternative 2.

The use of military expended materials - munitions during testing activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended materials - munitions during testing activities as described under Alternative 2 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals.

3.7.3.6.1.3 Impacts from Military Expended Materials –Munitions Under the No Action Alternative

Impacts from Military Expended Materials –Munitions Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various ingestion stressors (e.g., military expended materials - munitions) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.7.3.6.2 Impacts from Military Expended Materials Other than Munitions

Several different types of materials other than munitions are expended during training and testing activities in the HSTT Study Area. These include the following that have the potential to be ingested by marine mammals:

- target-related materials
- chaff (including fibers, end caps, and cartridges)
- flares (including end caps, compression pads/pistons, and o-rings)
- decelerators/parachutes (cloth, nylon, and metal weights)

- biodegradable polymer

Target-Related Materials

At-sea targets are usually remotely operated airborne, surface, or subsurface traveling units, most of which are designed to be recovered for reuse. If they are severely damaged or displaced, targets may sink before they can be retrieved. Expendable targets include air-launched decoys, marine markers (smoke floats), cardboard boxes, and 10 ft. diameter red balloons tethered by a sea anchor. Most target fragments would sink quickly in the sea. Floating material, such as Styrofoam, may be lost from target boats and remain at the surface for some time, however during target recovery, personnel would collect as much floating debris and Styrofoam as possible.

Chaff

Chaff is an electronic countermeasure designed to reflect radar waves and obscure aircraft, vessels, and other equipment from radar tracking sources. Chaff is composed of an aluminum alloy coating on glass fibers of silicon dioxide (U.S. Department of the Air Force, 1997). It is released or dispensed in cartridges or projectiles that contain millions of chaff fibers. When deployed, a diffuse cloud of fibers undetectable to the human eye is formed. Chaff is a very light material that can remain suspended in air anywhere from 10 minutes to 10 hours and can travel considerable distances from its release point, depending on prevailing atmospheric conditions (Arfsten et al., 2002; U.S. Department of the Air Force, 1997). Doppler radar has tracked chaff plumes containing approximately 900 grams of chaff drifting 200 mi. from the point of release, with the plume covering greater than 400 cubic meters (1,667 cubic kilometers) (Arfsten et al., 2002).

The chaff concentrations that marine mammals could be exposed to following release of multiple cartridges (e.g., following a single day of training) is difficult to accurately estimate because it depends on several unknown factors. First, specific release points are not recorded and tend to be random, and chaff dispersion in air depends on prevailing atmospheric conditions. After falling from the air, chaff fibers would be expected to float on the sea surface for some period, depending on wave and wind action. The fibers would be dispersed further by sea currents as they float and slowly sink toward the bottom. Chaff concentrations in benthic habitats following release of a single cartridge would be lower than the values noted in this section, based on dispersion by currents and the enormous dilution capacity of the receiving waters.

Several literature reviews and controlled experiments have indicated that chaff poses little risk, except at concentrations substantially higher than those that could reasonably occur from military training (Arfsten et al., 2002; U.S. Department of the Air Force, 1997; U.S. Department of the Navy, 1999). Nonetheless, some marine mammal species within the Study Area could be exposed to chaff through direct body contact and ingestion. Chemical alteration of water and sediment from decomposing chaff fibers is not expected to result in exposure. Based on the dispersion characteristics of chaff, it is likely that marine mammals would occasionally come in direct contact with chaff fibers while at the water's surface and while submerged, but such contact would be inconsequential. Chaff is similar to fine human hair (U.S. Department of the Air Force, 1997). Because of the flexibility and softness of chaff, external contact would not be expected to impact most wildlife (U.S. Department of the Air Force, 1997) and the fibers would quickly wash off shortly after contact. Given the properties of chaff, skin irritation is not expected to be a problem (U.S. Department of the Air Force, 1997). U.S. Department of the Air Force (1997); U.S. Department of the Navy (1999) and Arfsten et al. (2002) reviewed the potential effects of chaff inhalation on humans, livestock, and animals and concluded that the fibers are too large to be inhaled into the lung. The fibers are predicted to be deposited in the nose, mouth, or trachea and are either swallowed or expelled; however, these reviews did not specifically consider marine mammals.

Based on the small size of chaff fibers, it appears unlikely that marine mammals would confuse the fibers with prey or purposefully feed on chaff fibers. However, marine mammals could occasionally ingest low concentrations of chaff incidentally from the surface, water column, or seafloor. While no studies were conducted to evaluate the effects of chaff ingestion on marine mammals, the effects are expected to be negligible, based on the low concentrations that could reasonably be ingested, the small size of chaff fibers, and available data on the toxicity of chaff and aluminum. In laboratory studies conducted by the University of Delaware (U.S. Department of the Navy, 1999), blue crabs and killifish were fed a food-chaff mixture daily for several weeks and no significant mortality was observed at the highest exposure treatment. Similar results were found when chaff was added directly to exposure chambers containing filter-feeding menhaden. Histological examination indicated no damage from chaff exposures. A study on calves that were fed chaff found no evidence of digestive disturbance or other clinical symptoms (U.S. Department of the Air Force, 1997). Based on the dispersion characteristics of chaff, it is possible that marine mammals would occasionally come in direct contact with chaff fibers while either at the water's surface or while submerged, but such contact would be inconsequential.

Chaff cartridges and end caps would also be released into the marine environment, where they would persist for long periods and could be ingested by marine mammals while initially floating on the surface and sinking through the water column. Chaff end caps would eventually sink in saltwater to the seafloor (Spargo, 2007), which reduces the likelihood of ingestion by marine mammals at the surface or in the water column.

Flares

Flares are designed to burn completely. The only material that would enter the water would be a small, round, plastic compression pad or piston (0.45 to 4.1 g depending on flare type). The flare pads and pistons float in sea water.

An extensive literature review and controlled experiments conducted by the United States Air Force demonstrated that self-protection flare use poses little risk to the environment or animals (U.S. Department of the Air Force, 1997). Nonetheless, marine mammals within the vicinity of flares could be exposed to light generated by the flares. Pistons, end caps, and o-rings from flares would have the same impact on marine mammals as discussed under chaff cartridges. It is unlikely that marine mammals would be exposed to any chemicals that produce either flames or smoke since these components are consumed in their entirety during the burning process. Animals are unlikely to approach or get close enough to the flame to be exposed to any chemical components.

Decelerators/Parachutes

As noted previously in Section 3.0.3.3.5.2 (Decelerators/Parachutes), decelerators/parachutes are classified into four different categories based on size: small, medium, large, and extra-large. The majority of expended decelerators/parachutes are in the small category associated with the use of sonobuoys. Decelerators/parachutes in the three remaining size categories (medium -up to 19 ft. in diameter; large - between 30 and 50 ft. in diameter; and extra-large - up to 80 ft. in diameter) are likely too big to be mistaken for prey items and ingested by a marine mammal. Therefore, only the small size decelerators/parachutes are considered further as potential ingestion stressors.

The majority of decelerators/parachutes expended are weighted and by design specification must sink below the surface within five minutes of contact with the water. Once on the seafloor, decelerators/parachute become flattened (Environmental Sciences Group, 2005). Ingestion of a small decelerator/parachute by a marine mammal at the surface or within the water column would be unlikely, since the decelerator/parachute would not be available for very long before it sinks. Once on the seafloor, if bottom currents are present, the canopy may temporarily billow and be available for potential ingestion by marine animals with bottom-feeding habits.

Based on the information summarized above within the introduction to Section 3.7.3.6 (Ingestion Stressors), mysticetes found within the HSTT Study Area, with the exception of bottom-feeding gray whales and humpback whales, are not expected to encounter decelerators/parachutes on the seafloor because they do not feed there. In general, the majority of the decelerators/parachutes (from sonobuoys) would be expended in deep ocean areas where gray whales and humpback whales do not feed. Ingestion of decelerators/parachutes by odontocetes and pinnipeds is unlikely but is possible if individuals are feeding on the bottom. Sea otters are not expected to be present in the deep water areas where decelerator/parachutes may be released, would not encounter these items, and the species is not further analyzed in this section.

Biodegradable Polymer

As stated in Section 3.0.3.3.5.3 (Biodegradable Polymer), based on the constituents of the biodegradable polymer, it is anticipated that the material will breakdown into small pieces within a few days to weeks. These small pieces will breakdown further and dissolve into the water column within weeks to a few months and could potentially be incidentally ingested by marine mammals. 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.

3.7.3.6.2.1 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

As presented in Section 3.0.3.3.6 (Ingestion Stressors), military expended materials other than munitions would be expended during training activities under Alternative 1 within the HSTT Study Area.

Target related material, chaff, flares, decelerators/parachutes, and their subcomponents have the potential to be ingested by a marine mammal, although that is considered unlikely since most of these materials would quickly drop through the water column and settle on the seafloor; some Styrofoam, plastic endcaps, and other small items may float for some time before sinking.

While the smaller items discussed here may pose a hazard to marine mammals, as discussed for non-explosive practice munitions ingestion, the impacts of ingesting these forms of expended materials on marine mammals would be minor because of the following factors:

- The limited geographic area where materials other than munitions are expended during a given event
- The limited period of time these military expended materials would remain in the water column
- The unlikely chance that a marine mammal might encounter and swallow these items on the seafloor, particularly given that many of these items would be expended over deep, offshore waters

The impacts of ingesting military expended materials other than munitions would be limited to cases where an individual marine mammal might eat an indigestible item too large to be passed through the gut. The marine mammals would not be preferentially attracted to these military expended materials, with the possible exception of decelerators/parachutes that may appear similar to the prey of some species such as sperm whales and beaked whales. For the most part, these military expended materials would most likely only be incidentally ingested by individuals feeding on the bottom in the precise location where these items were deposited. Non-munition military expended materials that would remain floating on the surface are too small to pose a risk of intestinal blockage to any marine mammal that happened to encounter it.

Navy training activities that expend non-munition military expended materials may occur within the MHI Insular false killer whale's critical habitat, but are not likely to occur within the Hawaiian monk seal's designated critical habitat. The Navy does not anticipate that MHI Insular false killer whales or Hawaiian monk seals would ingest non-munition military expended materials. The features of monk seal critical habitat discussed in Section 3.7.2.2.9.1 (Status and Management) would not be impacted by military expended material other than munitions.

The use of military expended materials other than munitions during training activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended materials other than munitions during training activities as described under Alternative 1 would have no effect on MHI Insular false killer whale or Hawaiian monk seal critical habitat, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Military Expended Materials Other Than Munitions Under Alternative 1 for Testing Activities

As presented in Section 3.0.3.3.6 (Ingestion Stressors), military expended materials other than munitions would be expended during testing activities under Alternative 1 within the HSTT Study Area.

Target related material, chaff, flares, decelerators/parachutes, biodegradable polymers, and their subcomponents have the potential to be ingested by a marine mammal, although that is considered unlikely since most of these materials would quickly drop through the water column and settle on the seafloor. Some Styrofoam, plastic endcaps, and other small items may float for some time before sinking. In addition, biodegradable polymer fragments would only be temporarily available within the water column as they tend to disintegrate fairly quickly.

While the smaller items discussed here may pose a hazard to marine mammals, as discussed for non-explosive practice munitions ingestion, the impacts of ingesting these forms of expended materials on marine mammals would be minor because of the following factors:

- The limited geographic area where materials other than munitions are expended during a given event
- The limited period of time these military expended materials would remain in the water column
- The unlikely chance that a marine mammal might encounter and swallow these items on the seafloor, particularly given that many of these items would be expended over deep, offshore waters

The impacts of ingesting military expended materials other than munitions would be limited to cases where an individual marine mammal might eat an indigestible item too large to be passed through the gut. The marine mammals would not be preferentially attracted to these military expended materials, with the possible exception of decelerators/parachutes that may appear similar to the prey of some species such as sperm whales and beaked whales. For the most part, these military expended materials would most likely only be incidentally ingested by individuals feeding on the bottom in the precise location where these items were deposited. Military expended materials other than munitions that would remain floating on the surface are too small to pose a risk of intestinal blockage to any marine mammal that happened to encounter it.

Navy testing activities that expend non-munition military expended materials may occur within the MHI Insular false killer whale's critical habitat, but are not likely to occur within the Hawaiian monk seal's designated critical habitat. The Navy does not anticipate that MHI Insular false killer whales or Hawaiian monk seals would ingest non-munition military expended materials. The features of monk seal critical habitat discussed in Section 3.7.2.2.9.1 (Status and Management) would not be impacted by military expended material other than munitions.

The use of military expended materials other than munitions during testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA. 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 military expended materials other than munitions during testing activities as described under Alternative 1 would have no effect on MHI Insular false killer whales or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals. The Navy has consulted with NMFS and the USFWS as required by section 7(a)(2) of the ESA.

3.7.3.6.2.2 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

As presented in Section 3.0.3.3.6 (Ingestion Stressors), the locations and number of military expended materials other than munitions used during training activities under Alternative 2 is identical to Alternative 1. Therefore, the analysis presented in Section 3.7.3.6.2.1 (Impacts from Military Expended Materials Other than Munitions Under Alternative 1) for training activities would also apply to training activities proposed under Alternative 2.

The use of military expended materials other than munitions during training activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended materials other than munitions during training activities as described under Alternative 2 would have no effect on MHI Insular false killer whales or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals.

Impacts from Military Expended Materials Other Than Munitions Under Alternative 2 for Testing Activities

As presented in Section 3.0.3.3.6 (Ingestion Stressors), the locations and number of military expended materials other than munitions used during testing activities under Alternative 2 is identical to Alternative 1 with the exception of an inconsequentially small (less than 2 percent) increase in the number of decelerator/parachutes. The fractional increase in amount of military expended materials other than munitions would not substantially increase the potential for marine mammals to ingest these items. Therefore, the analysis presented in Section 3.7.3.6.2.1 (Impacts from Military Expended Materials Other than Munitions Under Alternative 1) for testing activities would also apply to testing activities proposed under Alternative 2.

The use of military expended materials other than munitions during testing activities as described under Alternative 2 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, the use of military expended materials other than munitions during testing activities as described under Alternative 2 would have no effect on MHI Insular false killer whales or Hawaiian monk seal critical habitats, but may affect ESA-listed marine mammals.

3.7.3.6.2.3 Impacts from Military Expended Materials Other Than Munitions Under the No Action Alternative

Impacts from Military Expended Materials Other than Munitions Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various ingestion stressors (e.g., military expended materials other than munitions) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.7.3.7 Secondary Stressors

This section analyzes potential impacts on marine mammals exposed to stressors indirectly through impacts on their habitat (sediment or water quality) or prey. For the purposes of this analysis, indirect impacts on marine mammals via sediment or water quality that do not require trophic transfer (e.g., bioaccumulation) in order to be observed are considered here. Bioaccumulation considered previously in this document in the analysis of fish (Section 3.6), invertebrates (Section 3.4), and marine habitats (Section 3.5) indicated minimal to no impacts on potential prey species of marine mammals. It is important to note that the terms “indirect” and “secondary” do not imply reduced severity of environmental consequences, but instead describe how the impact may occur in an organism. Additionally, the transportation of marine mammals (the Navy’s marine mammal system) in association with force protection and mine warfare exercises is presented to detail the lack of potential for the introduction of disease or parasites from those marine mammals to the Study Area. The potential for impacts from all these secondary indirect stressors are discussed below.

Stressors from Navy training and testing activities could pose indirect impacts on marine mammals via habitat or prey. These include (1) sound energy from sonar and other transducers or explosives, (2) explosive byproducts and unexploded munitions, (3) metals, (4) chemicals, (5) transmission of disease and parasites, and (6) seafloor devices consisting of anchors/moorings. Analyses of the potential impacts on sediment and water quality are discussed in Section 3.2 (Sediments and Water Quality).

As discussed in Appendix K (Geographic Mitigation Assessment), there are marine mammals resident to, or engaging in migratory, reproductive, and feeding behaviors within certain areas in the HSTT Study Area. Marine mammals in those areas may be affected by secondary stressors from Navy training and testing. Secondary stressors may result in a behavioral response but would not result in resident marine mammals avoiding these areas or result in the abandonment of behaviors in these areas.

Explosives

As it pertains to marine mammals, 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 blast. As described in Chapter 2 (Description of Proposed Action and Alternatives) Tables 2.6-2 through 2.6-5, training and testing events resulting in underwater explosions will occur in the Study Area.

In addition to physical effects of an underwater blast, prey might have behavioral reactions to underwater sound. Measurements of underwater detonations during training events in the Southern California Range Complex found that 90 percent of the released energy is contained in the frequency range from 50 to 2,500 Hz (Soloway & Dahl, 2015), which is within the range that could be sensed by marine mammal prey items. For instance, prey species might exhibit a strong startle reaction to explosions that might include swimming to the surface or scattering away from the source. This startle and flight response is the most common secondary defense among animals (Hanlon & Messenger, 1996; Mather, 2004). The abundances of prey species near the detonation point could be diminished for a short period of time before being repopulated by animals from adjacent waters. Alternatively, any prey species that would be directly injured or killed by the blast could draw in scavengers from the surrounding waters that would feed on those organisms, and in turn could be susceptible to becoming directly injured or killed by subsequent explosions. This type of scavenger behavior has been observed with Hawaiian monk seals in Hawaii (Uyeyama et al., 2012) and California sea lions in Southern California (Marshall, 2008) in shallow water areas, however there are no records of pinnipeds or other marine mammals having been injured or otherwise impacted by subsequent explosions while scavenging. Any of these scenarios would be temporary, only occurring during activities involving explosives, and no lasting effect on prey availability or the pelagic food web would be expected. The Navy will implement mitigation (e.g., not conducting gunnery activities within a specified distance of shallow-water coral reefs) to avoid or reduce potential impacts from explosives and physical disturbance and strike stressors on seafloor resources in mitigation areas throughout the Study Area (see Section 5.4.1, Mitigation Areas for Seafloor Resources). This mitigation will consequently help avoid potential impacts from explosives on marine mammal prey species that inhabit shallow-water coral reefs, live hard bottom, precious coral beds, artificial reefs, and shipwrecks.

Explosion Byproducts, and Unexploded Munitions

High-order explosions consume most of the explosive material, creating typical combustion byproducts. In the case of Royal Demolition Explosive, also known as cyclonite and hexogen, 98 percent of the products are common seawater constituents, and the remainder is rapidly diluted below threshold effect level (see Section 3.2, Sediments and Water Quality, Table 3.2-9). Explosion byproducts associated with high order detonations present no indirect stressors to marine mammals through sediment or water. However, low order detonations and unexploded munitions present elevated likelihood of impacts on marine mammals.

Deposition of undetonated explosive materials into the marine environment can be reasonably well estimated by the known failure and low-order detonation rates of high explosives (see Section 3.2, Sediments and Water Quality, Table 3.2-7). While it is remotely possible for marine mammals to come into contact with an undetonated explosive, to have contact with unexploded materials in the sediment or water and or to ingest unexploded materials in sediments as secondary stressors, it is very unlikely for the following reasons.

Indirect impacts of explosives and unexploded munitions to marine mammals via sediment contamination is possible only if a marine mammal ingested the sediment. Degradation of explosives proceeds through several pathways, as discussed in Section 3.2.3.1 (Explosives and Explosives Byproducts). Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen & Lotufo, 2010). Relatively low solubility of most explosives and their degradation products means that concentrations of these contaminants in the marine environment are relatively low and readily diluted. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately 6–12 in. away from degrading munitions, the concentrations of these compounds were not statistically distinguishable from background beyond 3 to 6 ft. from the degrading munitions (Section 3.2.3.1, Explosives and Explosives Byproducts). Taken together, it is possible that marine mammals could be exposed to degrading explosives, but it would be within a very small radius of the explosive (1 to 6 ft.). Gray whales, humpback whales, odontocetes, and pinnipeds are the only species in the HSTT Study Area that might routinely ingest sediments while feeding in shallow water, however this feeding does not occur in the deep water areas where unexploded materials are more likely to occur.

A series of research efforts focused on World War II underwater munitions disposal sites in Hawaii (Briggs et al., 2016; Edwards et al., 2016; Kelley et al., 2016; Koide et al., 2016; University of Hawaii, 2010) and an intensively used live fire range in the Mariana Islands (Smith & Marx, 2016) provide information in regard to the impacts of undetonated materials and unexploded munitions on marine life. Section 3.2.3.1 (Explosives and Explosives Byproducts) and Section 3.2.3.3 (Metals) contains a summary of this literature which investigated water and sediment quality impacts, on a localized scale, from munitions ocean disposal sites and ocean disposed dredge spoils sites. Findings from these studies indicate that there were no adverse impacts on the local ecology from the presence of degrading munitions and there was no bioaccumulation of munitions-related chemicals in local marine species.

On a localized scale, research at World War II munitions ocean disposal sites in Hawaii investigated nearby sediments, seawater, or marine life to determine if released constituents from the munitions (including explosive components and metals) could be detected. Comparisons were made between disposal site samples and "clean" reference sites. The samples analyzed showed no confirmed detection for explosives. For metals, although there were localized elevated levels of arsenic and lead in several biota samples and in the sediment adjacent to the munitions, the origin of those metals could not be definitively linked to the munitions since comparison of sediment between the clean reference site and the disposal site showed relatively little difference. This was especially the case for a comparison with samples for ocean disposed dredge spoils sites (locations where material taken from the dredging of harbors on Oahu was disposed). At individual sampling sites adjacent to munitions, the concentrations of metals were not significantly higher as compared to the background at control sites and not significant in comparison to typical deep-sea marine sediments (Briggs et al., 2016). Observations and data collected also did not indicate any adverse impact on the localized ecology due to the presence of munitions degrading for over 75 years when compared to control sites. When specifically looking at marine organisms around the munitions (Kelley et al., 2016; Koide et al., 2016), the analysis indicated that in soft bottom habitats the expended items were providing hard substrate similar to other disposed objects or "artificial reefs" that attracted "hard substrate species" that would not have otherwise colonized the area and that there was no bioaccumulation of munitions-related chemicals for the species sampled (Koide et al., 2016). In summary, multiple investigations since 2007 involving survey and sampling of WWII munition dump sites off Oahu Hawaii, have found the following: (1) chemicals and degradation products from underwater munitions "do not pose a risk to human health or to fauna living in direct contact with munitions"; (2) metals measured in sediment samples next to WWII munitions are lower than naturally occurring marine levels and "do not cause a significant impact on the environment"; and (3) sediment is not a significant sink of chemicals released by degradation of the explosive components in munitions (Edwards et al., 2016). This would indicate a lack of impact on benthic marine mammal prey as a secondary stressor.

On a broader scale, the island of Farallon de Medinilla (in the Mariana Islands) has been used as a target area since 1971. Between 1997 and 2012, there were 14 underwater scientific survey investigations around the island providing a long term look at potential impacts on the marine life from training and testing involving the use of munitions (Smith & Marx, 2016). Munitions use has included HE rounds from gunfire, HE bombs by Navy aircraft and U.S. Air Force B-52s, in addition to the expenditure of inert rounds and non-explosive practice bombs. Marine life assessed during these surveys included algae, corals, benthic invertebrates, sharks, rays, and bony fishes, and sea turtles. The investigators found no evidence over the 16-year period, that the condition of the biological resources had been adversely impacted to a significant degree by the training activities (Smith & Marx, 2016). Furthermore, they found that the health, abundance, and biomass of fishes, corals and other marine resources were comparable to or superior to those in similar habitats at other locations within the Mariana Archipelago.

These findings are consistent with other assessments such as that done for the Potomac River Test Range at Dahlgren, Virginia which was established in 1918 and is the nation's largest fully instrumented, over-the-water gun-firing range. Munitions tested at Dahlgren has included rounds from small caliber guns up to the Navy's largest (16 inch guns), bombs, rockets, mortars, grenades, mines, depth charges, and torpedoes (U.S. Department of the Navy, 2013d). Results from the assessment indicate that munitions expended at Naval Surface Warfare Center, Dahlgren have not contributed significant concentrations of metals to the Potomac River water and sediments given those contributions are orders of magnitude less than concentrations already present in the Potomac River from natural and manmade sources (U.S. Department of the Navy, 2013d).

The concentration of munitions/explosions, expended material, or devices in any one location in the HSTT Study Area would be a small fraction of that from a World War II dump site, or a target island used for 45 years, or a water range in a river used for almost 100 years. Based on findings from much more intensively used locations, the water quality effects from the use of munitions, expended material, or devices resulting from any of the activities associated with the Proposed Action would be negligible by comparison. As a result, explosion by-products and unexploded munitions would have no meaningful effect on water quality and would therefore not constitute a secondary indirect stressor for marine mammals.

Metals

Metals are introduced into seawater and sediments as a result of training and testing activities involving ship hulks, targets, munitions, and other military expended materials (Section 3.2.3.3, Metals, and Environmental Sciences Group (2005)). Some metals bioaccumulate and physiological impacts begin to occur only after several trophic transfers concentrate the toxic metals (Section 3.5, Habitats, and Chapter 4.0, Cumulative Impacts). Evidence from a number of studies (Briggs et al., 2016; Kelley et al., 2016; Koide et al., 2016; U.S. Department of the Navy, 2013d; University of Hawaii, 2010) indicate metal contamination is very localized and that bioaccumulation resulting from munitions cannot be demonstrated. Specifically in sampled marine life living on or around munitions on the seafloor, metal concentrations could not be definitively linked to the munitions since comparison of metals in sediment next to munitions show relatively little difference in comparison to other "clean" marine sediments used as a control/reference (Koide et al., 2016). Research has demonstrated that some smaller marine organisms are attracted to metal munitions as a hard substrate for colonization or as shelter (Kelley et al., 2016; Smith & Marx, 2016), but this is unlikely to substantively impact marine mammal prey availability.

Chemicals

Several Navy training and testing activities introduce chemicals into the marine environment that are potentially harmful in higher concentration; however, rapid dilution would occur and toxic concentrations are unlikely to be encountered. Chemicals introduced are principally from flares and propellants for missiles and torpedoes. Properly functioning flares, missiles, and torpedoes combust most of their propellants; leaving benign or readily diluted soluble combustion byproducts (e.g., hydrogen cyanide). Operational failures may allow propellants and their degradation products to be released into the marine environment. Flares and missiles that operationally fail may release perchlorate, which is highly soluble in water, persistent, and impacts metabolic processes in many plants and animals if in sufficient concentration. Such concentrations are not likely to persist in the ocean. Research has demonstrated that perchlorate did not bioconcentrate or bioaccumulate, which was consistent with the expectations for a water soluble compound (Furin et al., 2013). Perchlorate from failed expendable items is therefore unlikely to compromise water quality to that point that it would act as a secondary stressor to marine mammals. It should also be noted that chemicals in the marine environment as a result of Navy training and testing activities would not occur in isolation and are typically associated with military expended materials that release the chemicals while in operation. Because marine mammal avoidance of an expended flare, missile, or torpedo in the water is almost certain, it would further reduce the potential for introduced chemicals to act as a secondary stressor.

Transmission of Marine Mammal Diseases and Parasites

The U.S. Navy deploys trained Atlantic common bottlenose dolphins and California sea lions for integrated training involving two primary mission areas; to find objects such as inert mine shapes, and to detect swimmers or other intruders around Navy facilities such as piers. When deployed, the animals are part of what the Navy refers to as Marine Mammal Systems. These Marine Mammal Systems include one or more motorized small boats, several crew members, and a trained marine mammal. Based on the standard procedures with which these systems are deployed, it is not reasonably foreseeable that use of these marine mammals systems would result in the transmission of disease or parasites to cetacea or pinnipeds in the Study Area based on the following.

Each trained animal is deployed under behavioral control to find the intruding swimmer or submerged object. Upon finding the target of the search, the animal returns to the boat and alerts the animal handlers that an object or swimmer has been detected. In the case of a detected object, the human handlers give the animal a marker that the animal can bite onto and carry down to place near the detected object. In the case of a detected swimmer, animals are given a localization marker or leg cuff that they are trained to deploy via a pressure trigger. After deploying the localization marker or leg cuff the animal swims free of the area to return to the animal support boat. For detected objects, human divers or remote vehicles are deployed to recover the item. Swimmers that have been marked with a leg cuff are reeled-in by security support boat personnel via a line attached to the cuff.

Marine mammal systems deploy approximately 1 to 2 weeks before the beginning of a training exercise to allow the animals to acclimate to the local environment. Four to 12 marine mammals are involved per exercise. Marine Mammal Systems typically participate in object detection and recovery, both participating in mine warfare events, and assisting with the recovery of non-explosive mine shapes at the conclusion of an event. Marine Mammal Systems may also participate in port security and anti-terrorism/force protection events.

During the past 40 years, the Navy Marine Mammal Program has deployed globally. To date, there have been no known instances of deployment-associated disease transfer to or from Navy marine mammals. Navy animals are maintained under the control of animal handlers and are prevented from having sustained contact with indigenous animals.

When not engaged in the training event, Navy Marine Mammals are either housed in temporary enclosures or aboard ships involved in training exercises. All marine mammal waste is disposed of in a manner approved for the specific holding facilities. When working, sea lions are transported in boats and dolphins are transferred in boats or by swimming alongside the boat under the handler’s control. Their open-ocean time is under stimulus control and is monitored by their trainers.

Navy marine mammals receive excellent veterinarian care (per Secretary of the Navy Instruction 3900.41E). Appendix A, Section 8, of the Swimmer Interdiction Security System Final EIS (U.S. Department of the Navy, 2009) presents an overview of the veterinary care provided for the Navy's marine mammals. Appendix B, Section 2, of the Swimmer Interdiction Security System Final EIS presents detailed information on the health screening process for communicable diseases. The following is a brief summary of the care received by all of the Navy's marine mammals:

- Qualified veterinarians conduct routine and pre-deployment health examinations on the Navy's marine mammals; only animals determined as healthy are allowed to deploy.
- Restaurant-quality frozen fish are fed to prevent diseases that can be caused by ingesting fresh fish (e.g., parasitic diseases).
- Navy animals are routinely dewormed to prevent parasitic and protozoal diseases.
- If a valid and reliable screening test is available for a regionally relevant pathogen (e.g., polymerase chain reaction assays for morbillivirus), such tests are run on appropriate animal samples to ensure that animals are not shedding these pathogens.

The Navy Marine Mammal Program routinely does the following to further mitigate the low risk of disease transmission from captive to wild marine mammals during training events:

- Marine mammal waste is disposed of in an approved system dependent upon the animal's specific housing enclosure and location.
- Onsite personnel are made aware of the potential for disease transfer, and report any sightings of wild marine mammals so that all personnel are alert to the presence of the animal.
- Marine mammal handlers visually scan for indigenous marine animals for at least 5 minutes before animals are deployed and maintain a vigilant watch while the animal is working in the water. If a wild marine mammal is seen approaching or within 100 m, the animal handler will hold the marine mammal in the boat or recall the animal immediately if the animal has already been sent on the mission.
- The Navy obtains appropriate state agriculture and other necessary permits and strictly adheres to the conditions of the permit which are included in the bulleted procedures provided above.

Due to the very small amount of time that the Navy marine mammals spend in the open ocean, the control that the trainers have over the animals, the collection and proper disposal of marine mammal waste, the exceptional screening and veterinarian care given to the Navy's animals, the visual monitoring for indigenous marine mammals, and more than 40 years with zero known incidents, there is no scientific basis to conclude that the use of Navy marine mammals during training activities will have an impact on wild marine mammals.

3.7.3.7.1 Impacts on Habitat

Secondary stressors impacts on habitat from explosives and byproducts, metals, chemicals, and transmission of disease and parasites are not expected to result in Level A or Level B harassment of any marine mammals.

As presented above in Section 3.7.3.7 (Secondary Stressors), Navy activities that introduce explosive byproducts and unexploded munitions, metals, and chemicals into the marine environment have not demonstrated long-term impacts on sediment and water quality. Explosive byproducts and unexploded munitions from ongoing Navy activities have not resulted in water quality impacts, and the likelihood of marine mammals being in contact with sediments contaminated from degrading explosives is low, given the small radius of impact around the location of the explosive. Furthermore, there is no evidence of bioconcentration or bioaccumulation of chemicals introduced by Navy activities that would alter water quality to an extent that would result in overall habitat degradation for marine mammals.

The MHI Insular false killer whales and the Hawaiian monk seal are the only marine mammal species with critical habitat located in the Study Area. For MHI Insular false killer whales, the essential feature of the critical habitat is island associated marine habitat. There are four characteristics supporting this feature consisting of (1) adequate space for movement and use within shelf and slope habitat, (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth, (3) waters free of pollutants of a type and amount harmful to the species, and (4) sound levels that will not significantly impair false killer whales' use or occupancy (82 FR 51186). As detailed in the other subsections of Section 3.7.3 (Environmental Consequences), the proposed action will have no effect on the essential feature characteristic consisting of adequate space for movement and use within shelf and slope habitat and will have no effect on the essential feature characteristic consisting of waters free of pollutants of a type and amount harmful to MHI Insular false killer whales, and therefore these two characteristics are not discussed further. Note that disturbance or injury to MHI Insular false killer whale prey (Characteristic 2) is discussed in the following subsection.

As presented in Section 3.7.3.1.2.3 (Impacts from Sonar and Other Transducers Under the Action Alternatives) and Section 3.7.3.2.2.3 (Impacts from Explosives Under the Action Alternatives), certain activities undertaken as part of the proposed action may affect individual MHI Insular false killer whales. MHI Insular false killer whale critical habitat covers approximately 49,300 km^2 of ocean around the main Hawaiian Islands. As a secondary stressor with regard to the characteristic of the critical habitat consisting of sound levels that will not significantly impair false killer whales' use or occupancy, the proposed action may affect MHI Insular false killer whale critical habitat for the reasons provided in the following. Impulsive and non-impulsive sources covered under the proposed action are not long-lasting, continuous over long temporal scales (> day), and/or persistent in the marine environment nor do they significantly raise local ambient sound levels over a significant portion of area where they are employed. In addition, mitigation areas have been specifically designed to limit the effect of hull-mounted sonar and in-water explosives in MHI insular false killer whale high-use areas and overlap the highest use areas of critical habitat as provided in Appendix K (Geographic Mitigation Assessment). Finally, research suggests that odontocetes, including false killer whales, do not abandon habitat as a result of exposure to mid-frequency active sonar. This conclusion is further supported by behavioral response studies demonstrating that displacement from an area for even the most sensitive species (beaked whales) is temporary, thereby indicating that mid-frequency sonar would not have an adverse effect on critical habitat. It should be noted that beaked whales appear to be much more sensitive to anthropogenic sounds than false killer whales, so displacement effects on MHI Insular false killer whales could be correspondingly much lower than on beaked whales.

For Hawaiian monk seals, the essential features of the critical habitat have been identified as (1) areas with characteristics preferred by monk seals for pupping and nursing, (2) shallow, sheltered aquatic areas adjacent to coastal locations preferred by monk marine areas from 0 to 500 m in depth seals for foraging, (4) areas with low levels of anthropogenic disturbance, (5) marine areas with adequate prey quantity and quality, and (6) significant areas used by monk seals for hauling out, resting, or molting (National Oceanic and Atmospheric Administration, 2015d). The identified features of the critical habitat, with the exception of marine areas with adequate prey quantity and quality, are not expected to be impacted by secondary stressors associated with the proposed Navy activities. Note that disturbance or injury to Hawaiian monk seal prey is discussed in the following subsection.

Seafloor devices, consisting of anchors or moorings, may remain in the environment for months or years, or may be left on the seafloor permanently and as a result may have potential impact on seafloor habitat where monk seals forage. In Hawaii, the majority of typical seafloor device use occurs in locations excluded from critical habitat designation including the Kingfisher Underwater Training area in marine areas off the northeast coast of Niihau, Pacific Missile Range Facility Offshore Areas in marine areas off the western coast of Kauai, the Puuloa Underwater Training Range in marine areas outside Pearl Harbor, Oahu, and the Shallow Water Minefield Sonar Training Range off the western coast of Kahoolawe in the Maui Nui area. Additionally, seafloor devices are typically deployed on sandy substrate; hardbottom is avoided. Seafloor devices left on the sandy or soft bottoms may contribute to enhanced benthic community structure, including monk seal prey species, starting with biological attaching organisms colonizing the structure and following with increased biodiversity in the immediate area. If deployed in hardbottom in an area of critical habitat, it is possible that a seafloor device could cover a crack in the seafloor where a foraging Hawaiian monk seal might have otherwise found prey. The designated monk seal critical habitat covers approximate 14,400 km^2 of seafloor (NMFS 2014). The subset of seafloor devices deployed outside the above mentioned Navy training and testing areas, in hardbottom portions of the critical habitat, could then potentially cover a monk seal foraging spot. As a result, Navy has determined that anchors left behind may affect monk seal critical habitat.

Impacts on habitat from secondary stressors associated with training and testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, impacts on habitat from secondary stressors associated with training and testing activities as described under Alternative 1 may affect MHI insular false killer whale critical habitat, Hawaiian monk seal critical habitat, and may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.7.3.7.2 Impacts on Prey Availability

Secondary stressors impacts on or prey from explosives and byproducts, metals, chemicals, and transmission of disease and parasites) are not expected to result in Level A or Level B harassment of any marine mammals.

As presented above in Section 3.7.3.7 (Secondary Stressors), Navy activities that introduce explosives, metals, and chemicals into the marine environment have not demonstrated long-term impacts on prey availability for marine mammals. The Navy's use of explosives have not demonstrated any lasting effects on prey availability for cetaceans. Bioaccumulation of metals from munitions in prey species has not been demonstrated and no effects to prey availability from metals and chemicals are known to occur.

The MHI Insular false killer whale and the Hawaiian monk seal are the only species with critical habitat located in the Study Area. One of the essential features of both these critical habitats was identified as being areas with sufficient quantity, quality, and availability of prey. Although disturbance or injury to a small number of fish is possible as a result of the Explosive Ordnance Disposal training in shallow water (Uyeyama et al., 2012), those spatially restricted effects to fish will not impact prey quantity and quality, and are discountable in that they are not expected to have any meaningful impact on MHI Insular false killer whales or Hawaiian monk seals in terms of prey availability. However, an impact on a prey species would constitute a secondary impact as defined in this analysis. Given the limited extent and rare nature of any impact on MHI Insular false killer whales or Hawaiian monk seal prey resulting from Explosive Ordnance Disposal training, it would not appreciably diminish the habitat or therefore result in secondary impact on the critical habitat.

Impacts on prey availability from secondary stressors associated with training and testing activities as described under Alternative 1 will not result in the unintentional taking of marine mammals incidental to those activities as defined under the MMPA.

Pursuant to the ESA, impacts on prey availability from secondary stressors associated with training and testing activities as described under Alternative 1 may affect MHI Insular false killer whale critical habitat, Hawaiian monk seal critical habitat, and may affect ESA-listed marine mammals. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.7.4 Summary of Potential Impacts on Marine Mammals

3.7.4.1 Combined Impacts of All Stressors Under Alternative 1

As described in Section 3.0.3.5 (Resource-Specific Impacts Analysis for Multiple Stressors), this section evaluates the potential for combined impacts of all the stressors from the Proposed Action. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in Sections 3.7.3.1 (Acoustic Stressors) through 3.7.3.6 (Ingestion Stressors) and, for ESA-listed species, summarized in Section 3.7.5 (Endangered Species Act Determinations). Stressors associated with Navy training and testing 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 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 testing or training 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, 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 training and testing 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 training and testing 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 training and small testing 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).

Secondly, a marine mammal could be exposed to multiple training and testing activities over the course of its life, however, training and testing 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 interactions are speculative, and without data on the combination of multiple Navy stressors, the synergistic impacts from the combination of Navy stressors are difficult to predict in any meaningful way. 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 (National Oceanic and Atmospheric Administration, 2013, 2015a) are that majority of impacts from Navy training and testing activities are not expected to have deleterious impacts on the fitness of any individuals or long-term consequences to populations of marine mammals.

Although potential impacts on certain marine mammal species from training and testing 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 3.7.5 (Endangered Species Act Determinations) and 3.7.6 (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).

3.7.4.2 Combined Impacts of All Stressors Under Alternative 2

Training and testing activities proposed under Alternative 2 would be an increase over what is proposed for Alternative 1. However, this increase is not expected to substantially increase the potential for impacts over what is analyzed for Alternative 1. The analysis presented in Section 3.7.4.1 (Combined Impacts of All Stressors Under Alternative 1) would similarly apply to Alternative 2. The combined Impacts of all stressors for training and testing activities under Alternative 2 are not expected to have deleterious impacts or long-term consequences to populations of marine mammals.

3.7.4.3 Combined Impacts of All Stressors Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. All stressors associated with Navy training and testing activities would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.7.5 Endangered Species Act Determinations

Pursuant to the ESA, the Navy has consulted with NMFS on Alternative 1 (the Preferred Alternative) as required by section 7(a)(2) of the ESA and determined that training and testing activities may affect the blue whale, fin whale, Western North Pacific DPS gray whale, Mexico DPS humpback whale, Central America DPS humpback whale, sei whale, sperm whale, main Hawaiian Islands insular false killer whale, Guadalupe fur seal, and Hawaiian monk seal. The Navy has also determined that training and testing activities may affect designated critical habitat for the Hawaiian monk seals and main Hawaiian Islands insular false killer whales, as defined by the ESA.

3.7.6 Marine Mammal Protection Act Determinations

The Navy is seeking Letters of Authorization in accordance with the MMPA from NMFS for certain training and testing activities (the use of sonar and other transducers, air guns, pile driving, vessels, and explosives), 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 air guns and pile driving may result in Level B harassment of certain marine mammal species. The use of explosives may result in Level A harassment, Level B harassment, and mortality of certain marine mammals. The use of vessels may result in Level A harassment or mortality due to potential physical strike. Refer to Section 3.7.3.1.2 (Impacts from Sonar and Other Transducers) for details on the estimated impacts from sonar and other transducers, Section 3.7.3.1.3 (Impacts from Air Guns) for details on the estimated impacts from air guns, Section 3.7.3.1.4 (Impacts from Pile Driving) for details on the estimated impacts from pile driving, Section 3.7.3.2 (Explosive Stressors) for impacts from explosives, and Section 3.7.3.4.1 (Impacts from Vessels and In-Water Devices) for details on the estimated impacts from vessels.

Weapons noise, vessel noise, aircraft noise, the use of in-water 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.

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3.8 Reptiles

Final
Environmental Impact Statement/Overseas Environmental Impact Statement
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3.8 Reptiles

PREFERRED ALTERNATIVE SYNOPSIS

The United States Department of the Navy (Navy) considered all potential stressors that reptiles could be exposed to from the Proposed Action. The following conclusions have been reached for the Preferred Alternative (Alternative 1):

- Acoustics: Navy training and testing activities have the potential to expose reptiles to multiple types of acoustic stressors, including sonars and other transducers; air guns; pile driving; and vessel, aircraft, and weapons noise. Reptiles could be affected by only a limited portion of acoustic stressors because they have limited hearing abilities. Exposures to sound-producing activities present risks that could range from hearing loss, auditory masking, physiological stress, and changes in behavior; however, no injurious impacts are predicted due to exposure to any acoustic stressor. Because the number of sea turtles potentially impacted by sound-producing activities is small, population-level effects are unlikely. Sea snakes considered in this analysis rarely occur in the Study Area; few, if any, impacts are anticipated from acoustic stressors on individual sea snakes, and no population-level effects would occur.
- Explosives: Explosions in the water or near the water's surface present a risk to reptiles located in close proximity to the explosion, because the shock waves produced by explosives can cause injury or result in the death; however, no sea turtle mortalities are predicted. If a sea turtle is farther from an explosion, the intense, impulsive, broadband sounds introduced into the marine environment may cause hearing loss, auditory masking, physiological stress, or changes in behavior. Because the number of sea turtles potentially impacted by explosives is small, population level effects are unlikely. Sea snakes considered in this analysis rarely occur in the Study Area; few, if any, impacts are anticipated from explosives on individual sea snakes, and no population-level effects would occur.
- Energy: Navy training and testing activities have the potential to expose reptiles to multiple energy stressors in offshore and inshore training and testing locations. The likelihood and magnitude of energy impacts depends on the proximity of a reptile to energy stressors. Based on the relatively weak strength of the electromagnetic field created by Navy activities, impacts on sea turtle migrating behaviors and navigational patterns are not anticipated. Potential impacts from high-energy lasers would only result for sea turtles directly struck by the laser beam. Statistical probability analyses demonstrate with a high level of certainty that no sea turtles would be struck by a high-energy laser. Activities using high-energy lasers would not occur in inshore training and testing locations. Energy stressors associated with Navy training and testing activities are temporary and localized in nature, and based on patchy distribution of reptiles, impacts on individual reptiles are unlikely and no impacts on populations are anticipated. Sea snakes considered in this analysis rarely occur in the Study Area; few, if any, impacts are anticipated from entanglement stressors on individuals, and no population-level effects would occur.

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- Physical Disturbance and Strike: Vessels, in-water devices, and seafloor devices present a risk for collision with sea turtles, particularly in coastal areas where densities are higher. Strike potential by expended materials is statistically small. Because of the low numbers of sea turtles potentially impacted by activities that may potentially cause a physical disturbance and strike, population-level effects are unlikely. Sea snakes considered in this analysis rarely occur in the Study Area, and few, if any, impacts are anticipated from physical disturbance and strike stressors.
- Entanglement: Sea turtles could be exposed to multiple entanglement stressors associated with Navy training and testing activities. The potential for impacts is dependent on the physical properties of the expended materials and the likelihood that a sea turtle would encounter a potential entanglement stressor and then become entangled in it. Physical characteristics of wires and cables, decelerators/parachutes, and biodegradable polymers combined with the sparse distribution of these items throughout the Study Area indicates a very low potential for sea turtles to encounter and become entangled in them. Long-term impacts on individual sea turtles and sea turtle populations from entanglement stressors associated with Navy training and testing activities are not anticipated. Sea snakes considered in this analysis rarely occur in the Study Area; few, if any, impacts are anticipated from entanglement stressors on individuals, and no population-level effects would occur.
- Ingestion: Navy training and testing activities have the potential to expose sea turtles to multiple ingestion stressors and associated impacts. The likelihood and magnitude of impacts depends on the physical properties of the military expended items, the feeding behaviors of sea turtles that occur in the Study Area, and the likelihood that a sea turtle would encounter and incidentally ingest the items. Adverse impacts from ingestion of military expended materials would be limited to the unlikely event that a sea turtle would be harmed by ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. The likelihood that a sea turtle would encounter and subsequently ingest a military expended item associated with Navy training and testing activities is considered low. Long-term consequences to sea turtle populations from ingestion stressors associated with Navy training and testing activities are not anticipated. Sea snakes considered in this analysis rarely occur in the Study Are; few, if any, impacts are anticipated from ingestion stressors on individuals, and no population-level effects would occur.

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- Secondary: Sea turtles could be exposed to multiple secondary stressors (indirect stressors to habitat or prey) associated with Navy training and testing activities in the Study Area. In-water explosions have the potential to injure or kill prey species that sea turtles feed on within a small area affected by the blast; however, impacts would not substantially impact prey availability for sea turtles. Explosion byproducts and unexploded munitions would have no meaningful effect on water or sediment quality; therefore, they are not considered to be secondary stressors for sea turtles. Metals are introduced into the water and sediments from multiple types of military expended materials. Available research indicates metal contamination is very localized and that bioaccumulation resulting from munitions would not occur. Several Navy training and testing activities introduce chemicals into the marine environment that are potentially harmful in concentration in the water column or in resuspended sediments; however, through rapid dilution, toxic concentrations are unlikely to be encountered by sea turtles. Furthermore, bioconcentration or bioaccumulation of chemicals introduced by Navy activities to levels that would significantly alter water quality and degrade sea turtle habitat has not been documented. Secondary stressors from Navy training and testing activities in the Study Area are not expected to have short-term impacts on individual sea turtles or long-term impacts on sea turtle populations. Sea snakes considered in this analysis rarely occur in the Study Area; few, if any, impacts are anticipated from secondary stressors on individuals, and no population-level effects would occur.

3.8.1 INTRODUCTION

This section provides a brief introduction to reptiles that occur within the boundaries of the Study Area and whose distribution may overlap with stressors associated with the Proposed Action. The National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS) share jurisdictional responsibility for sea turtles under the Endangered Species Act (ESA). USFWS has responsibility in the terrestrial environment (e.g., nesting beaches), while NMFS has responsibility in the marine environment. Sea snakes are not listed under the ESA; therefore, there are no regulatory agencies that manage this species for conservation purposes.

Sea turtles considered in this analysis are found in coastal waters and on nesting beaches of the Hawaiian Islands, coastal waters of California, and in open ocean areas. These species include green sea turtles (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), olive ridley sea turtle (*Lepidochelys olivii*), leatherback sea turtle (*Dermochelys coriacea*), and loggerhead sea turtle (*Caretta caretta*). Yellow-bellied sea snakes (*Pelamis platura*) passively drift in pelagic environments, and some of the pelagic currents that may carry sea snakes are within offshore waters of Hawaii. This species is believed to be extralimital in California (known from dead individuals washed ashore). Each species is discussed further in Section 3.8.2 (Affected Environment).

3.8.2 AFFECTED ENVIRONMENT

3.8.2.1 General Background

All reptiles are ectotherms, commonly referred to as "cold-blooded" animals that have adopted different strategies to use external sources of heat to regulate body temperature. Sea turtles are highly migratory, long-lived reptiles that occur throughout the open-ocean and coastal regions of the Study Area. Generally, sea turtles are distributed throughout tropical to subtropical latitudes, with some species extending into temperate seasonal foraging grounds. In general, sea turtles spend most of their time at sea, with female turtles returning to land to nest. Habitat and distribution vary depending on species and life stages and is discussed further in the species profiles and summarized in the following sections.

Sea snakes, also known as coral reef snakes, form a subfamily of venomous snakes closely related to the cobra and other terrestrial venomous snakes of Australia (Heatwole, 1999). Most species of sea snakes are adapted to a fully aquatic life, with few records on land (Udyawer et al., 2013). Only the yellow-bellied sea snake is thought to occur within the HSTT Study Area. Because of this species' passive drifting ecology, yellow-bellied sea snake sightings are reported in nearshore waters of Hawaii and California where they do not maintain resident breeding populations. Sightings in California are thought to be associated with the latest El Niño conditions and oceanic temperature warming trends and are discussed in more detail in Section 3.8.2.3.1 (Yellow-bellied Sea Snake [*Pelamis platura*]).

Additional species profiles and information on the biology, life history, species distribution, and conservation of reptile species can also be found on the following organizations:

- NMFS Office of Protected Resources (includes sea turtle species distribution maps),
- USFWS Ecological Services Field Office and Region Offices (for sea turtle nesting habitat and general locations of nesting beaches),
- Ocean Biogeographic Information System-Spatial Ecological Analysis of Megavertebrate Populations (known as OBIS-SEAMAP) species profiles,
- International Union for Conservation of Nature, Marine Turtle Specialist Group, and
- State resource agencies (specifically, Hawaii Division of Land and Natural Resources).

Detailed information about threats to these species and life history information can be found in the ESA listing documentation and their recovery plans (44 *Federal Register* 75074; 52 *Federal Register* 21059; 72 *Federal Register* 13027; (U.S. Fish and Wildlife Service, 1999).

3.8.2.1.1 Group Size

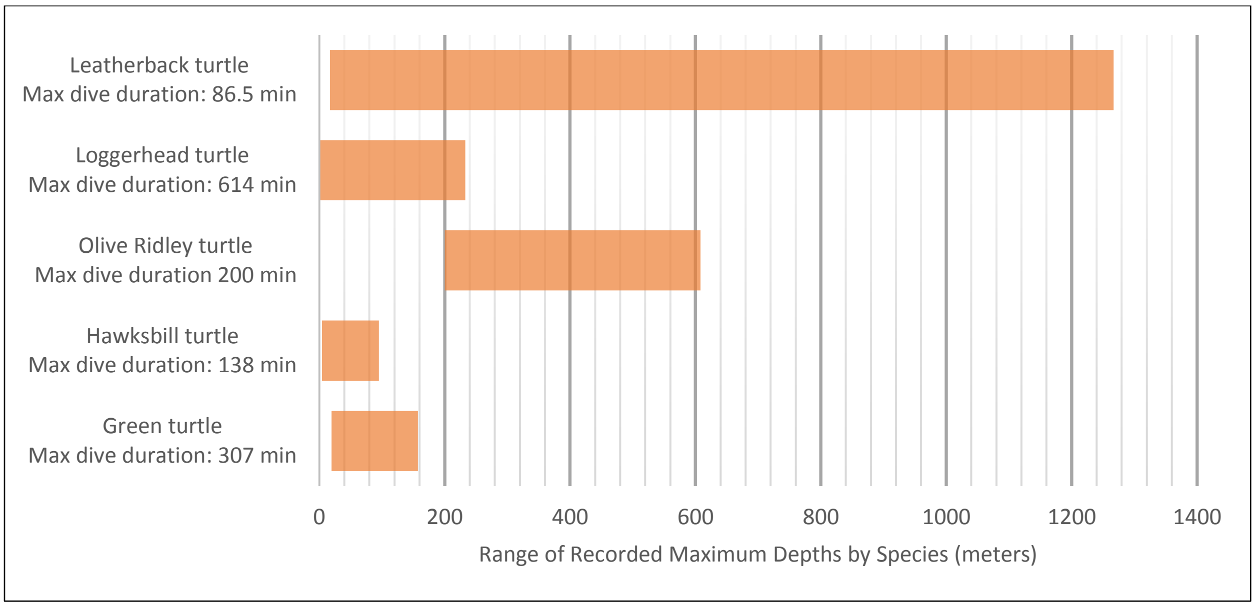
Sea turtles are generally solitary animals, but tend to group during migrations and mating. Because they do not show territoriality, foraging areas often overlap. New hatchlings, which often emerge from nesting beaches in groups, are solitary until they are sexually mature (Bolten, 2003; Bowen et al., 2004; James et al., 2005a; Schroeder et al., 2003). In pelagic waters, yellow-bellied sea snakes can be found in large groups, often associated with marine debris. Breeding areas are believed to be closer to shore within warmer waters outside of the Study Area (Brischoux et al., 2016).

3.8.2.1.2 Habitat Use

Sea turtles are dependent on beaches for nesting habitat, in locations that have sand deposits that are not inundated with tides or storm events prior to hatching. In the water, sea turtle habitat use is dependent on species and corresponds to dive behavior because of foraging and migration strategies, as well as behavior state (e.g., diving deep at night for resting purposes) (Rieth et al., 2011). Yellow-bellied sea snakes are born live (ovoviviparous), where young may be born in warm water tidal pools or in the tropical warm open ocean waters (Brischoux et al., 2016). Wide ranging in pelagic habitats, the yellow bellied sea snake depends on warm ocean currents as they move and hunt throughout the warm water pelagic environment.

3.8.2.1.3 Dive Behavior

Sea turtle dive depth and duration varies by species, the age of the animal, the location of the animal, and the activity (e.g., foraging, resting, and migrating). Dive durations are often a function of turtle size, with larger turtles being capable of diving to greater depths and for longer periods. The diving behavior of a particular species or individual has implications for mitigation, monitoring, and developing sound conservation strategies. In addition, their relative distribution through the water column is an important consideration when conducting acoustic exposure analyses. Methods of collecting dive behavior data over the years has varied in study design, configuration of electronic tags, parameters collected in the field, and data analyses. Hochscheid (2014) collected data from 57 studies published between 1986 and 2013, which summarized depths and durations of dives of datasets including an overall total of 538 sea turtles. Figure 3.8-1 presents the ranges of maximum dive depths for each sea turtle species found in the Study Area.

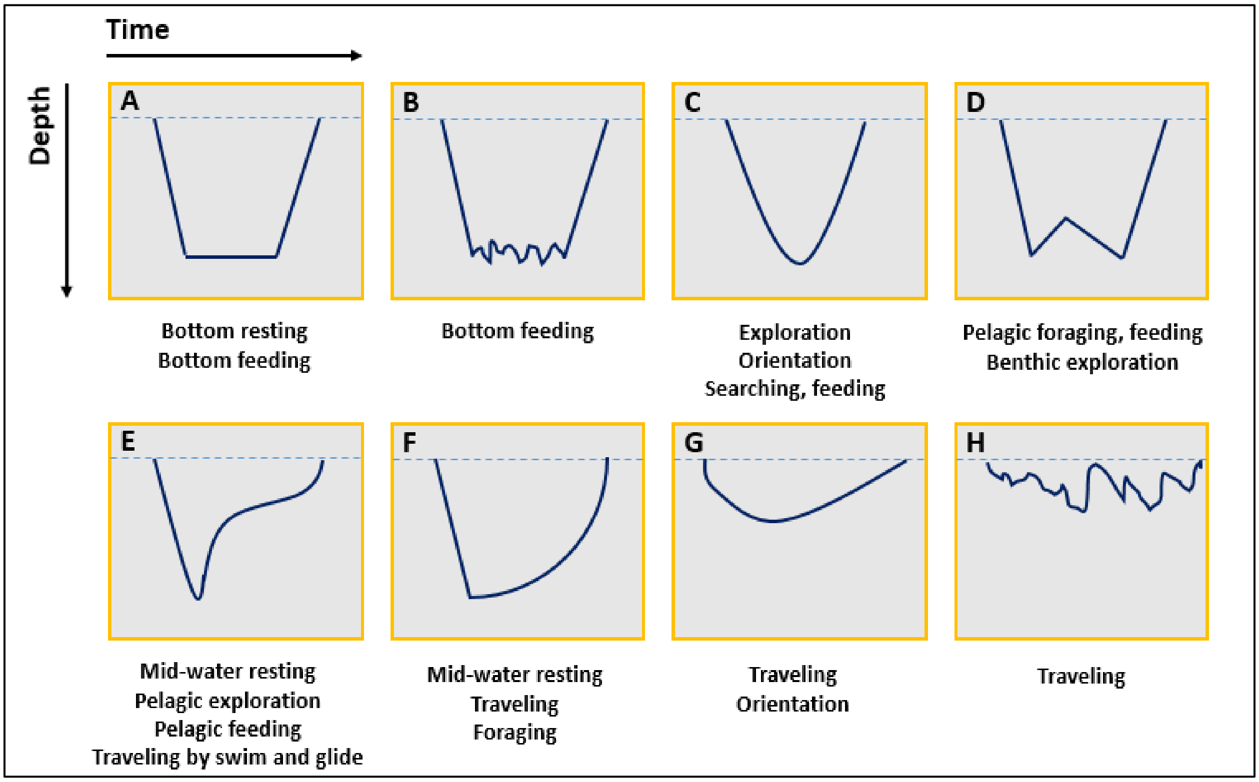


Sources: Hochscheid (2014); Sakamoto et al. (1993); (Rice & Balazs, 2008) ; Gitschlag (1996); Salmon et al. (2004)

Figure 3.8-1: Dive Depth and Duration Summaries for Sea Turtle Species

Hochscheid (2014) also collected information on generalized dive profiles, with correlations to specific activities, such as bottom resting, bottom feeding, orientation and exploration, pelagic foraging and feeding, mid-water resting, and traveling during migrations. Generalized dive profiles compiled from 11 different studies by Hochscheid (2014) show eight distinct profiles tied to specific activities. These profiles and activities are shown in Figure 3.8-2.

Little is known about yellow-bellied sea snake diving behavior. Yellow-bellied sea snakes likely forage only in pelagic environments, and are believed to forage on the surface to a depth of 10 meters (m) (Brischoux et al., 2016). Cook et al. (2015) implanted temperature-depth loggers on three other sea snake species in New Caledonia. Logging 1,850 dives, nearly all dives were less than 30 m deep, with an average dive depth of approximately 11 m. A maximum dive duration was approximately 124 minutes.



Sources: Hochscheid (2014); Rice and Balazs (2008), Sakamoto et al. (1993), Houghton et al. (2003), Fossette et al. (2007), Salmon et al. (2004), Hays et al. (2004); Southwood et al. (1999).

Figure 3.8-2: Generalized Dive Profiles and Activities Described for Sea Turtles

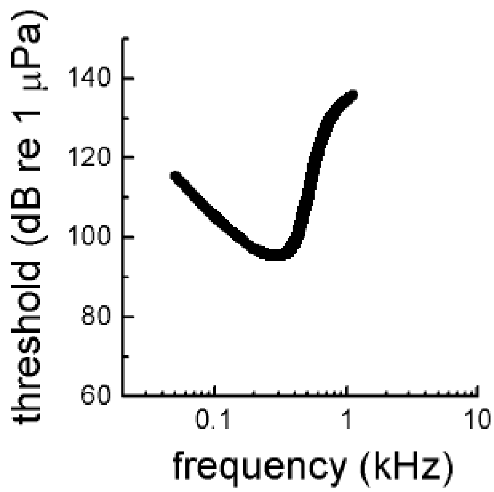
Notes: Profiles A-H, as reported in the literature and compiled by Hochscheid (2014). The depth and time arrows indicate the axis variables, but the figure does not represent true proportions of depths and durations for the various profiles. In other words, the depths can vary greatly, but behavioral activity seems to dictate the shape of the profile. Profiles G and H have only been described for shallow dives (less than 5 m).

3.8.2.1.4 Hearing and Vocalization

3.8.2.1.4.1 Sea Turtles

Sea turtle ears are adapted for hearing underwater and in air, with auditory structures that may receive sound via bone conduction (Lenhardt et al., 1985), via resonance of the middle ear cavity (Willis et al., 2013), or via standard tympanic middle ear path (Hetherington, 2008). Studies of hearing ability show that sea turtles' ranges of in-water hearing detection generally lie between 50 and 1600 hertz (Hz), with maximum sensitivity between 100 and 400 Hz, and that hearing sensitivity drops off rapidly at higher frequencies. Sea turtles are also limited to low frequency hearing in air, with hearing detection in juveniles possible between 50 and 800 Hz, and a maximum hearing sensitivity around 300–400 Hz (Bartol & Ketten, 2006; Piniak et al., 2016). Hearing abilities have primarily been studied with sub-adult, juvenile, and hatchling subjects in four sea turtle species, including green (Bartol & Ketten, 2006; Ketten & Moein-Bartol, 2006; Piniak et al., 2016; Ridgway et al., 1969; Yudhana et al., 2010), olive ridley (Bartol & Ketten, 2006), loggerhead (Bartol et al., 1999; Lavender et al., 2014; Martin et al., 2012), and leatherback (Dow Piniak et al., 2012). Only one study examined the auditory capabilities of an adult sea turtle (Martin et al., 2012); the hearing range of the adult loggerhead sea turtle was similar to other measurements of juvenile and hatchling sea turtle hearing ranges.

Using existing data on sea turtle hearing sensitivity, the U.S. Department of the Navy (Navy) developed a composite sea turtle audiogram for underwater hearing (Figure 3.8-3), as described in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017a).



Source: U.S. Department of the Navy (2017a)

Figure 3.8-3: Composite Underwater Audiogram for Sea Turtles

Notes: dB re 1 μPa: decibels referenced to 1 micropascal, kHz = kilohertz

The role of underwater hearing in sea turtles is unclear. Sea turtles may use acoustic signals from their environment as guideposts during migration and as cues to identify their natal beaches (Lenhardt et al., 1983). However, they may rely more on other senses, such as vision and magnetic orientation, to interact with their environment (Avens, 2003; Narazaki et al., 2013).

Sea turtles are not known to vocalize underwater. Some sounds have been recorded during nesting activities ashore, including belch-like sounds and sighs (Mrosovsky, 1972), exhale/inhales, gular pumps, and grunts (Cook & Forrest, 2005) by nesting female leatherback sea turtles; and low-frequency pulsed and harmonic sounds by leatherback embryos in eggs and hatchlings (Ferrara et al., 2014).

3.8.2.1.4.2 Sea Snakes

Currently no studies have been conducted on sea snake hearing. However, hearing has been researched in land-borne snakes, and it is suspected that sea snakes have similar hearing anatomy. All land-borne snakes lack external and middle ear structures but retain a single ear bone, the columella auris (Hartline, 1971), which interacts with the inner ear. In snakes, the columella auris is connected to the lower jaw bone (Christensen et al., 2012; Hartline, 1971). Therefore, since the lower jaw bone directly conducts substrate vibrations, snakes have an acute sensitivity to substrate vibrations (Hartline, 1971). Based on hearing abilities in land-borne snakes (Christensen et al., 2012; Hartline, 1971), it is suspected that sea snakes have a very limited hearing range and may use other senses for interacting with their environment. For example, turtle-headed sea snakes (*Emydocephalus annulatus*) rely primarily on scent for chemical cueing of prey (Shine et al., 2004).

Land-borne snakes have been shown to have highest in-air hearing sensitivity below 400 Hz (Christensen et al., 2012; Hartline, 1971). Given land-borne snakes hear sound-induced vibrations conducted by their body (Christensen et al., 2012), their in-water hearing sensitivity is likely similar to in-air sensitivities. Since sea snakes are suspected to have hearing anatomy similar to land-borne snakes, their highest in-water hearing sensitivity is believed to range from 80 to 160 Hz. At present, no information has been found indicating that sea snakes vocalize.

3.8.2.1.5 General Threats

3.8.2.1.5.1 Water Quality

Water quality in sea turtle habitats can be affected by a wide range of activities. The potential for energy exploration and extraction activities to degrade nearshore and off-shore habitats are discussed in Section 3.8.2.1.5.2 (Commercial Industries). Marine debris in sea turtle habitats is discussed in Section 3.8.2.1.5.6 (Marine Debris). Chemical pollution and impacts on water quality is also of great concern, although its effects on reptiles are just starting to be understood in marine organisms (Aguilar de Soto et al., 2008; Jepson et al., 2016; Law et al., 2014; National Marine Fisheries Service, 2011, 2014; Ortmann et al., 2012; Peterson et al., 2015). Oil and other chemical spills are a specific type of ocean contamination that can have damaging effects on some sea turtle and other marine reptile species directly through exposure to oil or chemicals and indirectly due to pollutants' impacts on prey and habitat quality. Ingested plastics, discussed in more detail in Section 3.8.2.1.5.6 (Marine Debris), can also release toxins, such as bisphenol-A (commonly known as "BPA") and phthalates, and organisms may absorb heavy metals from the ocean and release those into tissues (Fukuoka et al., 2016; Teuten et al., 2007). Life stage, geographic location relative to concentrations of pollutants, and feeding preference affects the severity of impacts on reptiles associated with chemical pollution in the marine environment.

Within the Study Area, sea snakes are primarily pelagic, and only occur close to shore in more tropical environments outside of the Study Area. In these locations, sea snakes are likely more susceptible to water quality degradation, which may decrease prey availability.

3.8.2.1.5.2 Commercial Industries

One comprehensive study estimates that worldwide, 447,000 sea turtles are killed each year from bycatch in commercial fisheries around the world (Wallace et al., 2010). Lewison et al. (2014) compared bycatch using three different gear types (longline, gillnet, and trawling nets) for sea turtles, marine mammals, and seabirds. Sea turtles were most susceptible to bycatch, with the Mediterranean and waters off the Atlantic coast of South America as the two fisheries reporting the highest number of sea turtle mortalities (primarily through trawling) (Lewison et al., 2014). In U.S. fisheries, Finkbeiner et al. (2011) estimate that bycatch resulted in 71,000 sea turtle deaths per year prior to effective regulations that protect sea turtles (e.g., regulations adopted since the mid-1990s in different U.S. fisheries for turtle exclusion devices). Current mortality estimates are 94 percent lower (4,600 deaths) than pre-regulation estimates (Finkbeiner et al., 2011). The trend in bycatch reductions continues throughout the Study Area. For example, Eguchi et al. (2018) determined that current restrictions in West Coast fisheries (e.g., time-area closures for West Coast drift gill net fishery) have been effective, and suggested that if the fixed time-area closure regulation existed in the 1990s, 18 of 19 observed bycatch events in this fishery could have been avoided.

Large-scale commercial exploitation also contributes to global decline in marine turtle populations. Currently, 42 countries and territories allow direct take of turtles and collectively take in excess of 42,000 turtles per year, the majority of which (greater than 80 percent) are green sea turtles (Humber et al., 2014). Illegal fishing for turtles and nest harvesting also continues to be a major cause of sea turtle mortality, both in countries that allow sea turtle take and in countries that outlaw the practice (Lam et al., 2011; Maison et al., 2010). For example, Humber et al. (2014) estimated that in Mexico 65,000 sea turtles have been illegally harvested since 2000. The authors, however, noted a downward trend of legal and illegal direct takes of sea turtles over the past three decades—citing a greater than 40 percent decline in green sea turtle take since the 1980s, a greater than 60 percent decline in hawksbill and leatherback take, and a greater than 30 percent decline in loggerhead take (Humber et al., 2014).

Boat strike has been identified as one of the important mortality factors in several nearshore turtle habitats worldwide. Precise data are lacking for sea turtle mortalities directly caused by ship strikes; however, live and dead turtles are often found with deep cuts and fractures indicative of collision with a boat hull or propeller (Hazel et al., 2007; Lutcavage & Lutz, 1997). For example, scientists in Hawaii reported that 2.5 percent of green sea turtles found dead on the beaches between 1982 and 2003 had been killed by boat strike (Chaloupka et al., 2008), and in the Canary Islands, 23 percent of stranded sea turtles showed lesions from boat strikes or fishing gear (Oros et al., 2005). Denkinger et al. (2013) reports that boat strikes in the Galapagos Islands were most frequent at foraging sites close to a commercial and tourism port.

Onshore development can lead to nesting habitat loss or habitat degradation. Construction activities can facilitate erosion or inhibit natural sediment deposition to form beaches. Once facilities are operational, artificial lighting, noise, and other stressors can degrade nesting habitats (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2011; Seminoff et al., 2015). Two utility-grade offshore wind projects are in the early planning stages for Hawaii (Smith et al., 2015). Projects generating electricity in offshore areas may also use wave generation technologies. While no projects are planned for West Coast states, waters off of Oregon and Washington have the most potential for wave generation, with a targeted installed capacity of 500 megawatts by 2025 (Parkinson et al., 2015). These early individual projects will not likely harm sea turtles or disrupt behaviors because of their northern location, but an increasing trend in offshore energy development may present a cumulative threat to sea turtles in nearshore environments with higher sea turtle concentrations. The anticipated increase in renewable energy development in coastal waters and deeper sites on the continental shelf will require increased vessel traffic, seismic surveys, and possibly pile driving activities for the turbine footings (Pacific Fishery Management Council, 2011), all of which may potentially stress sea turtles and their habitats.

The main threat to sea snakes globally is fisheries bycatch. Milton (2001) determined that the impact is relatively low, with prawn fisheries presenting the highest risk to sea snakes.

3.8.2.1.5.3 Disease and Parasites

Fibropapillomatosis is a disease of sea turtles that results in the production of tumors, both external and internal, that are considered benign, but may obstruct crucial functions, such as swimming, feeding, sight, and buoyancy, and can lead to death (Balazs, 1986; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1991; Patrício et al., 2016; Work & Balazs, 2013). The disease was first noticed in 1928, and was not observed again until the 1970s (McCorkle, 2016). The disease shows the highest prevalence among green sea turtles (Patrício et al., 2016), with rapid spread of the disease through the 1980s, becoming an endemic in both Florida and Hawaii in green sea turtle populations (McCorkle, 2016; Work & Balazs, 2013). By 1995 the concentration of disease in the population reached its climax and has showed a decline in prevalence since (Patrício et al., 2016).

Edmonds et al. (2016) lists 16 parasites known to occur in sea turtles, with the most common and significant (in terms of impacts on health) being blood flukes and flatworms (Watson et al., 2017). Some of the common external parasites found on sea turtles include leeches and a number of different species that reside on the shell called epibiota (Suzuki et al., 2014). Leeches are usually seen around where the flippers attach to the rest of the body. Parasitic isopods (e.g., sea lice) can attach themselves to sea turtle soft tissue on the outside and within the mouth (Júnior et al., 2015).

There is no available information regarding disease of sea snakes and parasites that infect internal organs or external surfaces of sea snakes.

3.8.2.1.5.4 Invasive Species

Invasive species have been shown to have both harmful and beneficial impacts on sea turtles. Impacts on sea turtles associated with invasive species primarily concern nest predation and prey base. Nests and eggs in the Northwestern Hawaiian Islands are at low risk of predation, but eggs deposited on beaches in the main Hawaiian Islands may be consumed by a variety of introduced species (e.g., mongooses, rats, feral dogs and cats, pigs, ants). In foraging grounds, sea turtles have been shown to adapt their foraging preferences for invasive seagrass and algae. Becking et al. (2014) showed green sea turtle foraging behavior shift to consumption of *Halophila stipulacea*, a rapidly spreading seagrass in the Caribbean. In Hawaii, green sea turtles in Kaneohe Bay have modified their diets over several decades to include seven non-native species (*Acanthophora spicifera, Hypnea musciformis, Gracilaria salicornia, Eucheuma denticulatum, Gracilaria tikvahiae, Kappaphycus striatum,* and *Kappaphycus alvarezii*), with non-native algae accounting for over 60 percent of sea turtle diet (Russell & Balazs, 2015).

There is no information available on the potential impact of invasive species on sea snakes.

3.8.2.1.5.5 Climate Change

Sea turtles are particularly susceptible to climate change effects because their life history, physiology, and behavior are extremely sensitive to environmental temperatures (Fuentes et al., 2013). Climate change models predict sea level rise and increased intensity of storms and hurricanes in tropical sea turtle nesting areas (Patino-Martinez et al., 2008). These factors could significantly increase beach inundation and erosion, thus affecting water content of sea turtle nesting beaches and potentially inundating nests (Pike et al., 2015). Climate change may negatively impact turtles in multiple ways and at all life stages. These impacts may include the potential loss of nesting beaches due to sea level rise and increasingly intense storm surge (Patino-Martinez et al., 2008), feminization of turtle populations from elevated nest temperatures (and skewing populations to more females than males unless nesting shifts to northward cooler beaches) (Reneker & Kamel, 2016), decreased reproductive success (Clark & Gobler, 2016; Hawkes et al., 2006; Laloë et al., 2016; Pike, 2014), shifts in reproductive periodicity and latitudinal ranges (Birney et al., 2015; Pike, 2014), disruption of hatchling dispersal and migration, and indirect effects to food availability (Witt et al., 2010). While rising temperatures may initially result in increased female population sizes, the lack of male turtles will likely impact the overall fertility of females in the population (Jensen et al., 2018). For example, breeding male sea turtles show strong natal philopatry (the tendency for animals to return to their birth places to mate) (Roden et al., 2017; Shamblin et al., 2015). With fewer available breeding males, it is unlikely that available males from other locations would interact with females in male-depleted breeding areas (Jensen et al., 2018).

Adaption strategies to protect coastal infrastructure are an anticipated response to rising sea levels. These activities may include shoreline stabilization projects and infrastructure hardening, which could contribute to the loss of nesting habitat. Shoreline stabilization may hold in place beach sediments in a specific location; however, the disruption of onshore currents can reduce the beach replenishment of sediments further away (Boyer et al., 1999; Fish et al., 2008).

Climate change may increase the likelihood of sea snakes moving into locations outside of their normal range. Although recent sightings of sea snakes appear to be correlated with El Niño events, it is reasonable to assume that warming oceanic trends may facilitate range expansion Brischoux et al. (2016).

3.8.2.1.5.6 Marine Debris

Ingestion of marine debris can cause mortality or injury to sea turtles. The United Nations Environment Program estimates that approximately 6.4 million tons of anthropogenic debris enters the marine environment every year (United Nations Environmental Program, 2005). This estimate, however, does not account for cataclysmic events, such as the 2011 Japanese tsunami estimated to have generated 1.5 million tons of floating debris (Murray et al., 2015). Plastic is the primary type of debris found in marine and coastal environments, and plastics are the most common type of marine debris ingested by sea turtles (Schuyler et al., 2014). Sea turtles can mistake debris for prey; one study found 37 percent of dead leatherback sea turtles to have ingested various types of plastic (Mrosovsky et al., 2009), and Narazaki et al. (2013) noted an observation of a loggerhead exhibiting hunting behavior on approach to a plastic bag, possibly mistaking the bag for a jelly fish. Even small amounts of plastic ingestion can cause an obstruction in a sea turtle's digestive track and mortality (Bjorndal et al., 1994; Bjorndal, 1997), and hatchlings are at risk for ingesting small plastic fragments. Ingested plastics can also release toxins, such as bisphenol-A (commonly known as "BPA") and phthalates, or absorb heavy metals from the ocean and release those into tissues (Fukuoka et al., 2016; Teuten et al., 2007). Life stage and feeding preference affects the likelihood of ingestion. Sea turtles living in oceanic or coastal environments and feeding in the open ocean or on the seafloor may encounter different types and densities of debris, and may therefore have different probabilities of ingesting debris. In 2014, Schuyler et al. (2014) reviewed 37 studies of debris ingestion by sea turtles, showing that young oceanic sea turtles are more likely to ingest debris (particularly plastic), and that green and loggerhead sea turtles were significantly more likely to ingest debris than other sea turtle species.

Within the Study Area, sea snakes are primarily pelagic, with fish as their primary diet. Further, sea snakes rely on visual cues from fish during hunting activities. With fish as their primary dietary component, mistaking marine debris for a prey item is not likely.

3.8.2.2 Endangered Species Act-Listed Species

As shown in Table 3.8-1, there are five species of reptiles listed as Endangered or Threatened under the ESA in the Study Area. Life history descriptions of these species are provided in more detail in the following sections.

Table 3.8-1: Current Regulatory Status and Presence of Endangered Species Act-Listed Sea Reptiles in the Study Area

Species Name and Regulatory Status			*Presence in Study Area*		
Common Name	***Scientific Name***	***Endangered Species Act Status***	***Open Ocean***	***Large Marine Ecosystem***	***Inshore Waters***
Family Cheloniidae (hard-shelled sea turtles)					
Green Sea Turtle (East Pacific distinct population segment, Central North Pacific distinct population segment)	*Chelonia mydas*	Threatened[1]	Yes	California Current, Insular Pacific-Hawaiian	San Diego Bay, San Pedro Channel, Pearl Harbor, Kaneohe Bay[5]
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered[2]	Yes	California Current, Insular Pacific-Hawaiian	Pearl Harbor, Kaneohe Bay[5]
Olive Ridley Sea Turtle	*Lepidochelys olivacea*	Threatened, Endangered[4]	Yes	California Current, Insular Pacific-Hawaiian	Pearl Harbor, Kaneohe Bay[5]
Loggerhead Sea Turtle (North Pacific distinct population segment)	*Caretta caretta*	Endangered[3]	Yes	California Current, Insular Pacific-Hawaiian	No
Family Dermochelyidae (leatherback sea turtle)					
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	Yes	California Current, Insular Pacific-Hawaiian	No

[1] On April 6, 2016, NMFS and USFWS listed the Central West Pacific, Central South Pacific, and Mediterranean distinct population segments as endangered, while listing the other eight distinct population segments (Central North Pacific, East Indian-West Pacific, East Pacific, North Atlantic, North Indian, South Atlantic, Southwest Indian, and Southwest Pacific) as threatened. The HSTT Study Area shares portions of the geographic extents identified for the Central North Pacific and East Pacific distinct population segments.

[2] Research suggests that green and hawksbill sea turtles may be present in the Study Area in all life stages (National Marine Fisheries Service & U. S. Fish and Wildlife Service, 2007a, 2007b).

[3] The only distinct population segment of loggerheads that occurs in the Study Area—the North Pacific Ocean distinct population segment—is listed as Endangered.

[4] NMFS and U.S. Fish and Wildlife Service only consider the breeding populations of Mexico's Pacific coast as Endangered. Other populations found in east India, Indo-Western Pacific, and Atlantic are listed as Threatened.

[5] Indicates nesting activity within the Study Area portion. Only green sea turtles and hawksbill sea turtles are known to nest regularly in the Study Area.

3.8.2.2.1 Green Sea Turtle (*Chelonia mydas*)

3.8.2.2.1.1 Status and Management

The green sea turtle was first listed under the ESA in 1978. In 2016, NMFS and USFWS reclassified the species into 11 "distinct population segments," which maintains federal protections while providing a more tailored approach for managers to address specific threats facing different populations (see the NMFS and USFWS Final Rule published on April 6, 2016). The geographic areas that include these distinct population segments are: (1) North Atlantic Ocean, (2) Mediterranean Sea, (3) South Atlantic Ocean, (4) Southwest Indian Ocean, (5) North Indian Ocean, (6) East Indian Ocean – West Pacific Ocean, (7) Central West Pacific Ocean, (8) Southwest Pacific Ocean, (9) Central South Pacific Ocean, (10) Central North Pacific Ocean, and (11) East Pacific Ocean.

Only the Central North Pacific and East Pacific Ocean distinct population segments occur within the Study Area is within the Study Area. These segments are listed as threatened under the ESA. Only these distinct population segments are discussed further in the document; however, it should be noted that minimal mixing may occur (gene flow) with other population segments (Seminoff et al., 2015).

There is no critical habitat designated for the green sea turtle in the Study Area.

3.8.2.2.1.2 Habitat and Geographic Range

The green sea turtle is distributed worldwide across tropical and subtropical coastal waters generally between 45 degrees (°) north and 40° south. After emerging from the nest, green sea turtle hatchlings swim to offshore areas where they float passively in major current systems; however, laboratory and modeling studies suggest that dispersal trajectories might also be shaped by active swimming (Putman & Mansfield, 2015). Post-hatchling green sea turtles forage and develop in floating algal mats habitats of the open ocean. At the juvenile stage (estimated at five to six years), they leave the open-ocean habitat and retreat to protected lagoons and open coastal areas that are rich in seagrass or marine algae (Bresette et al., 2006), where they will spend most of their lives (Bjorndal & Bolten, 1988). The optimal developmental habitats for late juveniles and foraging habitats for adults are warm shallow waters (3–5 m), with abundant submerged aquatic vegetation and close to nearshore reefs or rocky areas (Holloway-Adkins, 2006; Seminoff et al., 2003a). Climate change and ocean warming trends may impact the habitat and range of this species over time (Fuentes et al., 2013). These impacts apply to all sea turtle species and are discussed in Section 3.8.2.1.5.5 (Climate Change).

Green sea turtles nest on beaches within the Hawaii portion of the Study Area, while they feed and migrate throughout all waters of the Study Area. Green sea turtles likely to occur in the Study Area come from eastern Pacific Ocean and Hawaiian nesting populations. There are very few reports of turtles from southern Pacific Ocean populations occurring in the northern Pacific Ocean (Limpus et al., 2009; Seminoff et al., 2015).

Migratory routes within the open ocean are unknown. The main source of information on distribution in the Study Area comes from catches in U.S. fisheries. About 57 percent of green sea turtles (primarily adults) captured in longline fisheries in the North Pacific Subtropical Gyre and North Pacific Transition Zone come from the Eastern Pacific distinct population segment, while 43 percent are from the North Central Pacific distinct population segment. These findings suggest that green sea turtles found on the high seas of the western and central Pacific Ocean are from these two populations. Though few observations of green sea turtles in the offshore waters along the U.S. Pacific coast have been verified, their occurrence within the nearshore waters from Baja California to Alaska indicates a presence in waters off of California (Stinson, 1984), including San Diego Bay (Turner-Tomaszewicz & Seminoff, 2012; U.S. Department of the Navy, 2013a).

The green sea turtle is the most common sea turtle species in the Hawaii region of the Study Area, occurring in the coastal waters of the main Hawaiian Islands throughout the year and commonly migrating seasonally to the Northwestern Hawaiian Islands to reproduce (Balazs & Chaloupka, 2006; Lotufo et al., 2013; Seminoff et al., 2015). Green sea turtles are found in inshore waters around all of the main Hawaiian Islands and Nihoa Island, where reefs, their preferred habitats for feeding and resting, are most abundant. They are also common in an oceanic zone surrounding the Hawaiian Islands. This area is frequently inhabited by adults migrating to the Northwestern Hawaiian Islands to reproduce during the summer and by ocean-dwelling individuals that have yet to settle into coastal feeding grounds of the main Hawaiian Islands (Lotufo et al., 2013). Farther offshore, green sea turtles occur in much lower numbers and densities (Seminoff et al., 2015).

Green sea turtles have been sighted in Pearl Harbor, but do not nest in the harbor; they are routinely seen in the outer reaches of the entrance channel. The number of resident turtles at the entrance channel is estimated at 30 to 40, with the largest number occurring at Tripod Reef and the Outfall Extension Pipe. They are also found beneath the outfall pipe of the Fort Kamehameha wastewater treatment plant, at depths of approximately 20 m. Green sea turtles are also regularly seen in West Loch (Hanser et al., In Prep.). In the spring of 2010, two green sea turtles nested at Pacific Missile Range Facility for the first time in more than a decade. The number of nests observed at this location has increased over the years with six successful nests producing 468 hatchlings (Hanser et al., In Prep.). Green sea turtles are also common at all three landing beaches of U.S. Marine Corps Base Hawaii in Kaneohe Bay, where they forage in the shallow water seagrass beds (Marine Corps Base Hawaii, 2011; Martínez-Abraín, 2008), with successful the first known successful hatching occurring in August 2010 (Marine Corps Base Hawaii, 2011).

The Navy conducts aerial surveys for sea turtles in Hawaii annually as a requirement under a Letter of Authorization (for compliance with the Marine Mammals Protection Act [MMPA]) for at-sea training in the Hawaii Range Complex. Sea turtles are observed and recorded opportunistically while surveying for marine mammals. Turtles can be spotted from a plane or helicopter during surveys. Based on these methods, sea turtle densities were calculated for each island that was surveyed. To account for sea turtles that were not at the surface during surveys (Buckland et al., 2001), a conservative estimate of 10 percent of turtles in the area were observed. Ninety percent were assumed to be present but not observable during the survey. Based on this analysis, year-round density values within the Hawaii Range Complex for green sea turtles were estimated to be highest around Oahu (1.1252 turtles/square kilometers [km^2]), with relatively lower densities in deeper waters beyond the 100 m isobaths (0.00429 turtles/km^2).

The green sea turtle is not known to nest anywhere on the U.S. West Coast, but ranges widely in nearshore waters as far as British Columbia (National Marine Fisheries Service & U. S. Fish and Wildlife Service, 2007a) with high concentrations in the subtropical coastal waters of southern Baja California, Mexico, and Central America (Chaloupka et al., 2004).

San Diego Bay is home to a resident population of green sea turtles (MacDonald et al., 2013; U.S. Department of the Navy, 2017b). A 20-year monitoring program of these turtles indicates an annual abundance between 16 and 61 turtles (Eguchi et al., 2010). Eelgrass beds and marine algae are particularly abundant in the southern half of the bay, and green sea turtles are frequently observed foraging on these items (U.S. Department of the Navy, 2013a). Until December 2010, the southern part of San Diego Bay was warmed by the effluent from the Duke Energy power plant, a fossil fuel power generation facility in operation since 1960. Both before and after closure of the power plant, turtles were distributed in significantly warmer waters than surrounding environments during winter months (December–February). Turtles in winter were rarely detected in water temperatures lower than 14.5 °C (Crear et al., 2016; Rosen & Lotufo, 2005). After the closing of the plant, home ranges increased slightly within south San Diego Bay, with some additional short-term utilization or transit through other areas of the bay (Schallman & Bredvik, 2016). However, the core habitat for most green sea turtles has consistently remained in south San Diego Bay (Schallman & Bredvik, 2016). Two of six green sea turtles tagged in 2015 with satellite tracking tags migrated out of San Diego Bay did leave the bay at some point during the tag lifespan. In November 2015, a male green sea turtle migrated to the Revillagigedo Island Archipelago off Mexico (Schallman & Bredvik, 2016). In December 2015 a female green sea turtle traveled from south San Diego Bay to outside of the Bay, headed north along Point Loma, turned south to just past the U.S.-Mexico border, and then returned to San Diego Bay. The remaining tagged turtles remained in the south San Diego Bay core area. Another green sea turtle population resides in the San Gabriel River, which empties into the Pacific Ocean south of Long Beach, California, although less is known about this population (Crear et al., 2016; Eguchi et al., 2010).

Ocean waters off Southern California and northern Baja California are also designated as areas of occurrence because of the presence of rocky ridges and channels and floating kelp habitats suitable for green sea turtle foraging and resting (Stinson, 1984); however, these waters are often at temperatures below the thermal preferences of this primarily tropical species and turtles found in these waters are likely transiting.

3.8.2.2.1.3 Population Trends

The Central North Pacific distinct population segment has seen an estimated 4.8 percent annual increase in nesting activity over the last 40 years (Seminoff et al., 2015). In-water abundance trends appear to also be increasing. A significant increase in catch per unit effort of green sea turtles was seen from 1982 to 1999 during bull-pen fishing conducted at Pala'au, Molokai, with anecdotal indications of increased abundance with more green sea turtle basking activity observed in the main Hawaiian Islands (Balazs & Chaloupka, 2006).

The East Pacific distinct population segment also shows an increasing population trend. This observed increase may have resulted from the onset of nesting beach protection in 1979—as is suggested by the similarity in timing between the onset of beach conservation and the age to maturity for green sea turtles along Pacific nesting beaches of Mexico (Seminoff et al., 2015).

3.8.2.2.1.4 Predator and Prey Interactions

The green sea turtle is the only species of sea turtle that, as an adult, primarily consumes plants and other types of vegetation (Mortimer, 1995; Nagaoka et al., 2012). While primarily herbivorous, a green sea turtle's diet changes substantially throughout its life. Very young green sea turtles are omnivorous (Bjorndal, 1997). Salmon et al. (2004) reported that post-hatchling green sea turtles were found to feed near the surface on seagrasses or at shallow depths on comb jellies and unidentified gelatinous eggs off the coast of southeastern Florida. Nagaoka et al. (2012) analyzed 50 incidentally caught juvenile green sea turtles in Brazil and determined that juveniles consumed an omnivorous diet, including terrestrial plants (floating in the water), algae, invertebrates, and seagrass. Sampson and Giraldo (2014) observed opportunistic foraging of tunicates (a type of filter-feeding marine invertebrate) by green sea turtles in the eastern tropical Pacific. Pelagic juveniles smaller than 8–10 inches (in.) in length eat worms, young crustaceans, aquatic insects, grasses, and algae (Bjorndal, 1997). After settling in coastal juvenile developmental habitat at 8–10 in. in length, they eat mostly mangrove leaves, seagrass and algae (Balazs et al., 1994; Nagaoka et al., 2012). Research indicates that green sea turtles in the open-ocean environment, and even in coastal waters, also consume jellyfish, sponges, and sea pens (Godley et al., 1998; Hatase et al., 2006; Heithaus et al., 2002; Parker & Balazs, 2008; Russell et al., 2011; Seminoff et al., 2015). Fukuoka et al. (2016) also noted that juvenile green sea turtles were at higher risk to marine debris ingestion, likely due to the resemblance of small pieces of debris to omnivorous dietary items.

The loss of eggs to land-based predators such as mammals, snakes, crabs, and ants occurs on some nesting beaches. As with other sea turtles, hatchlings may be preyed on by birds and fish. Sharks are the primary nonhuman predators of juvenile and adult green sea turtles at sea (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1991; Seminoff et al., 2015).

3.8.2.2.1.5 Species-Specific Threats

In addition to the general threats described previously in Section 3.8.2.1.5 (General Threats), damage to seagrass beds and declines in seagrass distribution can reduce foraging habitat for green sea turtles (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1991; Seminoff et al., 2015; Williams, 1988). Green sea turtles are susceptible to the disease fibropapillomatosis, which causes tumor-like growths (fibropapillomas) resulting in reduced vision, disorientation, blindness, physical obstruction to swimming and feeding, increased susceptibility to parasites, and increased susceptibility to entanglement (Balazs, 1986; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1991; Patrício et al., 2016; Work & Balazs, 2013). Some populations (e.g., the Florida population) have begun to show resistance to the disease, but it remains an issue for others, such as Pacific populations, and Hawaii's green sea turtles in particular (Chaloupka et al., 2009; Seminoff et al., 2015). Other factors, such as increased stressors and selection of healthy turtles during illegal poaching activities, may increase susceptibility of turtles (Patrício et al., 2016).

3.8.2.2.2 Hawksbill Sea Turtle (*Eretmochelys imbricata*)

3.8.2.2.2.1 Status and Management

The hawksbill sea turtle is listed as endangered under the ESA (35 *Federal Register* 8491). While the current listing as a single global population remains valid, data may support separating populations at least by ocean basin under the distinct population segment policy (Seminoff et al., 2015). The most recent status review document was released in 2013 by the NMFS and USFWS (Hill et al., 2017).

There is no critical habitat designated for hawksbill sea turtles in the Study Area.

3.8.2.2.2.2 Habitat and Geographic Range

The hawksbill is the most tropical of the world's sea turtles, rarely occurring above 35° N or below 30° south (Witzell, 1983). While hawksbills are known to occasionally migrate long distances in the open ocean, they are primarily found in coastal habitats and use nearshore areas more exclusively than other sea turtles. Hatchlings in the north Pacific may show different habitat and range preferences than hawksbill hatchlings in other regions, where the general progression is hatchling preference in open ocean environments and later juvenile-phase movements to coastal habitats. Van Houtan et al. (2016) suggest that hatchlings within the HSTT Study Area may move to coastal habitats and nearshore foraging grounds more quickly. Within the Study Area, nesting occurs only in the Hawaiian Islands. Nests have been noted each year on Maui and Molokai, with the majority of hawksbill nesting in the Hawaiian Islands taking place on the island of Hawaii (Van Houtan et al., 2016).

Less is known about the hawksbill's oceanic stage, but it is thought that neonates live in the oceanic zone where water depths are greater than 200 m. Distribution in the oceanic zone may be influenced by surface gyres (Gaos, 2011; Leon & Bjorndal, 2002).

Juveniles and adults share the same foraging areas, including tropical nearshore waters associated with coral reefs, hard bottoms, or estuaries with mangroves (Musick & Limpus, 1997). In nearshore habitats, resting areas for late juvenile and adult hawksbills are typically in deeper waters, such as sandy bottoms at the base of a reef flat (Houghton et al., 2003). As they mature into adults, hawksbills move to deeper habitats and may forage to depths greater than 90 m. During this stage, hawksbills are seldom found in waters beyond the continental or insular shelf unless they are in transit between distant foraging and nesting grounds (Renaud et al., 1996). Ledges and caves of coral reefs provide shelter for resting hawksbills during both day and night, where an individual often inhabits the same resting spot. Hawksbills are also found around rocky outcrops and high-energy shoals, where sponges are abundant, and in mangrove-fringed bays and estuaries. Female hawksbills return to their natal beach every two to three years to nest at night, every 14 to 16 days during the nesting season.

3.8.2.2.2.3 Population Trends

Within the 24 sites in the entire Pacific assessed by Mortimer and Donnelly (2008), 21 sites showed decreasing historic trends. Based on available data in Hawaii for the number of annual nesting females (from 1989 to 2002), the hawksbill nesting trend appears to be decreasing, with a possible recent increase in the past five years (Van Houtan et al., 2016). Less than 20 hawksbills are believed to nest on Hawaiian beaches (Van Houtan et al., 2016). Hawksbills in the eastern Pacific Ocean are probably the most endangered sea turtle population in the world (Gaos & Yañez, 2008). A lack of nesting beach surveys for hawksbill sea turtles in the Pacific Ocean and the poorly understood nature of this species' nesting have made it difficult for scientists to assess the population status of hawksbills in the Pacific (Gaos & Yañez, 2008; Seminoff et al., 2003b). The largest of these regional populations is in the South Pacific Ocean, where 6,000–8,000 hawksbills nest off the Great Barrier Reef (Limpus, 1992).

3.8.2.2.2.4 Predator and Prey Interactions

Hawksbill sea turtles have a varying diet and feeding habitat preference throughout different lifestages. Post-hatchling hawksbills feed on algae in floating habitats (e.g., *Sargassum*) in the open ocean (Plotkin & Amos, 1998; Van Houtan et al., 2016). During the later juvenile stage, hawksbills are considered omnivorous, feeding on sponges, sea squirts, algae, molluscs, crustaceans, jellyfish, and other aquatic invertebrates (Bjorndal, 1997). Older juveniles and adults are more specialized, feeding primarily on sponges, which compose as much as 95 percent of their diet in some locations (Meylan, 1988; Witzell, 1983). As adults, Hawksbill sea turtles fill a unique ecological niche in marine and coastal ecosystems, supporting the natural functions of coral reefs by keeping sponge populations in check, which may otherwise compete for space with reef-building corals (Hill, 1998; Leon & Bjorndal, 2002).

The loss of hawksbill eggs to predators such as feral pigs, mongoose, rats, snakes, crabs, and ants is a severe problem on some nesting beaches. As with other sea turtles, hatchlings may be preyed on by birds and fish. Sharks are the primary nonhuman predators of juvenile and adult hawksbills at sea (Hill et al., 2017; National Ocean Service, 2016).

3.8.2.2.2.5 Species-Specific Threats

In addition to the general threats described in Section 3.8.2.1.5 (General Threats), the greatest threat to hawksbills is harvest for commercial and subsistence use (Van Houtan et al., 2016). Direct harvest of eggs and nesting adult females from beaches, as well as direct hunting of turtles in foraging areas, continues in many countries. International trade of tortoise shells is thought to be the most important factor endangering the species worldwide. The second-most significant threat to hawksbill sea turtles is loss of nesting habitat caused by the expansion of human populations in coastal areas of the world, as well as the increased destruction or modification of coastal ecosystems to support tourism (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998a). Coastal pollution as a result of increased development degrades water quality, particularly coral reefs, which are primary foraging areas for hawksbills. Due to their preference for nearshore areas, hawksbills are particularly susceptible to nearshore fisheries gear such as drift nets, entanglement in gill nets, and capture on fish hooks of fishermen (Gaos, 2011; National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1993). Hawksbills in the North Pacific may occupy a variety of ecosystems, including coastal pelagic waters and shallow reefs in remote atolls, and therefore be exposed to threats specific to these environments (Van Houtan et al., 2016).

3.8.2.2.3 Olive Ridley Sea Turtle (*Lepidochelys olivacea*)

3.8.2.2.3.1 Status and Management

Olive ridley sea turtles that nest along the Pacific coast of Mexico are listed as endangered under the ESA, while all other populations are listed under the ESA as threatened (43 *Federal Register* 32800). Based on genetic data, the worldwide olive ridley population is composed of four main lineages: east India, Indo-Western Pacific, Atlantic, and eastern Pacific Ocean (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014; Shankar et al., 2004). Most olive ridley sea turtles found in Hawaiian waters are of the eastern Pacific Ocean lineage, with about a third from the Indo-Western Pacific lineage. Off of California, olive ridleys are thought to be within the eastern Pacific Ocean lineage (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014). There is no critical habitat designated for this species in the Study Area.

3.8.2.2.3.2 Habitat and Geographic Range

The olive ridley has a circumtropical distribution, occurring in the Atlantic, Pacific, and Indian Oceans (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014). In the eastern Pacific, olive ridleys typically occur in tropical and subtropical waters, as far south as Peru and as far north as California, but occasionally have been documented as far north as Alaska. Key arribada beaches include La Flor in Nicaragua, Nancite and Ostinal in Costa Rica, La Marinera and Isla Cañas in Panama, Gahirmatha, Rushikulya, and Devi River in India, and Eilanti in Suriname. Arribada is the common term for large concentrations of nesting activity.

Studies from different populations of olive ridley sea turtles show a strong preference for neretic areas (shallow part of the sea near a coast and overlying the continental shelf) (Plot et al., 2015; Polovina et al., 2004; Rees et al., 2016); however, deep water foraging has been documented in the north Pacific, where prey items are scattered and less predictable and migrate widely from nesting locations (Polovina et al., 2004). Comparing olive ridley habitat use in different regions, Plot et al. (2015) suggest that the differing migration patterns observed (i.e., oceanic migrations versus neritic movements) may be attributed to specific environmental conditions of the areas in close proximity to nesting sites.

Olive ridley sea turtles can dive and feed at considerable depths from 80 to 300 m (Chambault et al., 2016; Montero et al., 2016), although only about 10 percent of their foraging time is spent at depths greater than 100 m (Polovina et al., 2002). In the eastern tropical Pacific Ocean, at least 25 percent of their total dive time is spent between 20 and 100 m (Parker et al., 2003). While olive ridley sea turtles are known to forage to great depths, Polovina et al. (2002) found that most dives (approximately 70 percent) were no deeper than 15 m.

Rare instances of nesting occur in the Hawaiian Islands, with the first olive ridley nest documented in 1985 at Paia, Maui. A second nest was recorded in Hilo, Hawaii, in 2002, and a third olive ridley nest was recorded at Marine Corps Base Hawaii in Kaneohe Bay in 2009 (Marine Corps Base Hawaii, 2011).

3.8.2.2.3.3 Population Trends

The olive ridley is the most abundant sea turtle in the world, with the most recent at-sea estimates of density and abundance providing a population range of 1.15–1.62 million olive ridley sea turtles (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014). Although this is a dramatic decrease over the past 50 years, where the population from the five Mexican Pacific Ocean beaches was previously estimated at 10 million adults, short-term population trends appear to be increasing overall. The number of olive ridley sea turtles occurring in U.S. territorial waters is believed to be small (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998, 2014). At-sea abundance surveys conducted along the Mexican and Central American coasts between 1992 and 2006 provided an estimate of 1.39 million turtles in the region, which was consistent with the increases seen on the eastern Pacific Ocean nesting beaches between 1997 and 2006.

3.8.2.2.3.4 Predator and Prey Interactions

Olive ridley sea turtles are primarily carnivorous. They consume a variety of prey in the water column and on the seafloor, including snails, clams, tunicates, fish, fish eggs, crabs, oysters, sea urchins, shrimp, and jellyfish (Polovina et al., 2004). Olive ridleys are subject to predation by the same predators as other sea turtles, such as sharks on adult olive ridleys, fish and sharks on hatchlings, and various land predators on hatchlings (e.g., ants, crabs, birds, and mammals) (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998).

3.8.2.2.3.5 Species-Specific Threats

Besides the array of threats to sea turtles in general, most of the species-specific threats for olive ridleys in the east Pacific coast population are associated with nesting habitats along the eastern Pacific coast. Lutcavage et al. (1997) note that impacts on nesting habitats for olive ridley sea turtles include construction of buildings and pilings, beach armoring and nourishment, and sand extraction. These activities have increased in many parts of the olive ridley’s range and pose threats to major nesting sites in Central America (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2014).

3.8.2.2.4 Loggerhead Sea Turtle (*Caretta caretta*)

3.8.2.2.4.1 Status and Management

In 2009, a status review conducted for the loggerhead (the first turtle species subjected to a complete stock analysis) identified nine distinct population segments within the global population (Conant et al., 2009). In a September 2011 rulemaking, the NMFS and USFWS listed five of these distinct population segments as endangered and kept four as threatened under the ESA, effective as of October 24, 2011 (76 *Federal Register* 58868). The North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea distinct population segments of the loggerhead sea turtle are classified as endangered under the ESA, and the Southeast Indo-Pacific Ocean, Southwest Indian Ocean, Northwest Atlantic Ocean, and South Atlantic Ocean distinct population segments are classified as threatened. Only the North Pacific Ocean distinct population segment occurs within the Study Area; however, mixing is known to occur between other populations in the Pacific and Indian Oceans, enabling a limited amount of gene flow with other distinct population segments (Gaos, 2011).

There is no critical habitat designated for loggerhead sea turtles within the Study Area.

3.8.2.2.4.2 Habitat and Geographic Range

Loggerhead sea turtles occur in U.S. waters in habitats ranging from coastal estuaries to waters far beyond the continental shelf (Dodd, 1988). Loggerheads typically nest on beaches close to reef formations and in close proximity to warm currents (Dodd, 1988), preferring beaches facing the ocean or along narrow bays (National Marine Fisheries Service & U. S. Fish and Wildlife Service, 1998; Rice et al., 1984). Most of the loggerheads observed in the eastern North Pacific Ocean are believed to come from beaches in Japan where the nesting season is late May to August. Aschettino et al. (2015) found that most loggerheads that use the Southern California Bight are more similar, using stable isotope analysis, to loggerheads in the Central North Pacific, as opposed to loggerheads that nest in Baja. Migratory routes can be coastal or can involve crossing deep ocean waters (Schroeder et al., 2003). The species can be found hundreds of kilometers out to sea, as well as in inshore areas, such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Coral reefs, rocky areas, and shipwrecks are often used as feeding areas. The nearshore zone provides crucial foraging habitat, as well as habitat during nesting season and overwintering habitat.

Pacific Ocean loggerheads appear to use the entire North Pacific Ocean during development. There is substantial evidence that the North Pacific Ocean stock makes two transoceanic crossings. The first crossing (west to east) is made immediately after they hatch from the nesting beach in Japan, while the second (east to west) is made when they reach either the late juvenile or adult life stage at the foraging grounds in Mexico. Offshore, juvenile loggerheads forage in or migrate through the North Pacific Subtropical Gyre as they move between North American developmental habitats and nesting beaches in Japan. The highest densities of loggerheads can be found just north of Hawaii in the North Pacific Transition Zone (Polovina et al., 2000).

The North Pacific Transition Zone is defined by convergence zones of high productivity that stretch across the entire northern Pacific Ocean from Japan to California (Polovina et al., 2001). Within this gyre, the Kuroshio Extension Bifurcation Region is an important habitat for juvenile loggerheads (Polovina et al., 2006). These turtles, whose oceanic phase lasts a decade or more, have been tracked swimming against the prevailing current, apparently to remain in the areas of highest productivity. Juvenile loggerheads originating from nesting beaches in Japan migrate through the North Pacific Transition Zone en route to important foraging habitats in Baja California, and are likely to be found in the Transit Corridor of the Study Area (Bowen et al., 1995). Seminoff et al. (2014) report that waters off of the southern Baja Peninsula support a high abundance of loggerheads that originate from the Japanese nesting grounds.

The loggerhead sea turtle is known to occur at sea in the Southern California portion of the Study Area, but does not nest on Southern California beaches. Loggerhead sea turtles primarily occupy areas where the sea surface temperature is between 59 degrees Fahrenheit (°F) and 77°F (15 degrees Celsius [°C] and 25°C). In waters off of the U.S. West Coast, most records of loggerhead sightings, stranding events, and incidental bycatch have been of juveniles documented from the nearshore waters of Southern

California. In general, sea turtle sightings increase during the summer, peaking from July to September off Southern California and southwestern Baja California.

During El Niño events, foraging loggerheads from Mexican waters may expand their range north into Southern California waters. For this reason, U.S. Pacific Ocean waters east of 120° W longitude are closed to the large mesh drift gillnet fishery targeting swordfish and thresher shark during June, July, and August during a forecast or occurring El Niño event. These waters are considered an area of occurrence during the warm-water period. Allen et al. (2013) conducted stable isotope analysis on loggerheads in both the Southern California Bight and Central North Pacific loggerheads and noted strong genetic kinship among these population segments. Loggerheads are generally not found in waters colder than 60.8°F (16°C), so the area north of the 60.8°F (16°C) isotherm is depicted as an area of rare occurrence.

The loggerhead embarks on transoceanic migrations and has been reported as far north as Alaska and as far south as Chile. Loggerheads foraging in and around Baja California originate from breeding areas in Japan (Conant et al., 2009), while Australian stocks appear to migrate to foraging grounds off the coasts of Peru and Chile (Alfaro-Shigueto et al., 2004).

3.8.2.2.4.3 Population Trends

No loggerhead nesting occurs within the Study Area. The largest nesting aggregation in the Pacific Ocean occurs in southern Japan, where fewer than 1,000 females breed annually (Kamezaki et al., 2003). Despite historic long-term declines from Japan nesting beaches (50 to 90 percent), nesting populations in Japan have gradually increased since 2000 (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2007). Seminoff et al. (2014) carried out aerial surveys for loggerhead sea turtles along the Pacific Coast of the Baja California Peninsula, Mexico, confirming that the area is an important foraging habitat for North Pacific distinct population segment loggerheads. Additional aerial surveys conducted by NMFS Southwest Fisheries Science Center in the Southern California Bight resulted in 215 loggerhead sea turtle sightings over the course of one month in the fall of 2015 (Eguchi, 2015).

3.8.2.2.4.4 Predator and Prey Interactions

Loggerhead sea turtles are primarily carnivorous in both open ocean and nearshore habitats, although they also consume some algae (Bjorndal, 1997), Diet varies by age class (Godley et al., 1998) and by specializing in specific prey groups dependent on location (Besseling et al., 2015; Biggs et al., 2000). For post hatchlings that tend to be grouped in masses of *Sargassum* and other floating habitats, various diet analyses of gut contents show parts of *Sargassum*, zooplankton, jellyfish, larval shrimp and crabs, and gastropods (Browlow et al., 2016; Burkholder et al., 2004; Carr & Meylan, 1980; Richardson & McGillivary, 1991). Both juveniles and adults forage in coastal habitats, where they feed primarily on the bottom, although they also capture prey throughout the water column (Bjorndal, 2003). Adult loggerheads feed on a variety of bottom-dwelling animals, such as crabs, shrimp, sea urchins, sponges, and fish. They have powerful jaws that enable them to feed on hard-shelled prey, such as whelks and conch. During migration through the open sea, they eat jellyfish, molluscs, flying fish, and squid (Besseling et al., 2015; Rice et al., 1984).

Common predators of eggs and hatchlings on nesting beaches are ghost crabs, raccoons, feral pigs, foxes, coyotes, armadillos, and fire ants (Campbell, 2016; Dodd, 1988; Engeman et al., 2016). Eriksson and Burton (2003) has shown that management interventions for feral pigs and raccoons can significantly increase nest success in Florida, one of the main nesting concentrations of loggerheads. Committee on the Status of Endangered Wildlife in Canada (2009) documented an apparently rare instance of a jaguar (*Panthera onca*) a loggerhead sea turtle at Tortuguero National Park, Costa Rica, in 2014. In the water, hatchlings are susceptible to predation by birds and fish. Sharks are the primary predator of juvenile and adult loggerhead sea turtles (Fergusson et al., 2000).

3.8.2.2.4.5 Species-Specific Threats

Loggerheads that occur within the Study Area primarily originate from nesting grounds in Japan and use the North Pacific as migration and foraging grounds. Therefore, species-specific threats are limited to this geographic area. A primary threat to North Pacific loggerheads is the high degree of juvenile and adult mortality off the Baja California Peninsula. As discussed previously, this location is considered a biological hotspot for loggerheads in a location where bycatch and human consumption present significant threats (Fisheries and Oceans Canada, 2011, 2016a). Mortality associated with shrimp trawls has been a substantial threat to juvenile loggerheads because these trawls operate in the nearshore habitats commonly used by this species. Although shrimping nets have been modified with turtle excluder devices to allow sea turtles to escape, the overall effectiveness of these devices has been difficult to assess (Bugoni et al., 2008; Ellis, 2016). Shrimp trawl fisheries account for the highest number of loggerhead sea turtle fishery mortalities; however, loggerheads are also captured and killed in other trawls, traps and pots, longlines, and dredges. (Fisheries and Oceans Canada, 2011)

3.8.2.2.5 Leatherback Sea Turtle (*Dermochelys coriacea*)

3.8.2.2.5.1 Status and Management

The leatherback sea turtle is listed as a single population and is classified as endangered under the ESA (35 *Federal Register* 8491). Although USFWS and NMFS believe the current listing is valid, preliminary information indicates an analysis and review of the species should be conducted under the distinct population segment policy (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013). Recent information on population structure (through genetic studies) and distribution (through telemetry, tagging, and genetic studies) have led to an increased understanding and refinement of the global stock structure (Clark et al., 2010).

In 2012, NMFS designated critical habitat for the leatherback sea turtle in California (from Point Arena to Point Vincente) and from Cape Flattery, Washington, to Winchester Bay, Oregon, out to the 2,000-meter depth contour (National Marine Fisheries Service, 2012). This critical habitat designation is north of the Study Area.

3.8.2.2.5.2 Habitat and Geographic Range

The leatherback sea turtle is distributed worldwide in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans. Pacific leatherbacks are split into western and eastern Pacific subpopulations based on their distribution and biological and genetic characteristics. Eastern Pacific leatherbacks nest along the Pacific coast of the Americas, primarily in Mexico and Costa Rica, and forage throughout coastal and pelagic habitats of the eastern tropical Pacific. Western Pacific leatherbacks nest in the Indo-Pacific, primarily in Indonesia, Papua New Guinea and the Solomon Islands. A proportion of this population migrates north through the waters of Indonesia, Malaysia, Philippines, and Japan, and across the Pacific past Hawaii to feeding areas off the Pacific coast of North America. Another segment of the western subpopulation migrates into the southern hemisphere through the Coral Sea, into waters of the western South Pacific Ocean (National Marine Fisheries Service, 2016). The Western Pacific leatherback group is the primary stock that occurs within the Study Area.

Leatherback sea turtles are regularly sighted by fishermen in offshore waters surrounding the Hawaiian Islands, generally beyond the 3,800 foot (ft.) depth contour, and especially at the southeastern end of the island chain and off the northern coast of Oahu. Leatherbacks encountered in these waters, including those caught accidentally in fishing operations, may be migrating through waters surrounding Hawaii (National Marine Fisheries Service & U. S. Fish and Wildlife Service, 1998). Sightings and reported interactions with the Hawaii longline fishery commonly occur around seamount habitats above the Northwestern Hawaiian Islands (from 35°N to 45°N and 175°W to 180°W) (Skillman & Balazs, 1992; Skillman & Kleiber, 1998).

The leatherback sea turtle occurs in offshore areas surrounding the Hawaiian Islands beyond the 100 m isobath. Leatherbacks rarely occur inshore of this isobath. Incidental captures of leatherbacks have also occurred at several offshore locations around the main Hawaiian Islands (McCracken, 2000). Although leatherback bycatches are common off the island chain, leatherback-stranding events on Hawaiian beaches are uncommon. Since 1982, only five leatherbacks strandings have been reported in the Hawaiian Islands. Aerial and shipboard surveys in nearshore Hawaiian waters also suggest that nearshore occurrences are extremely rare (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013). Leatherbacks were not sighted during any of the NMFS shipboard surveys; their deep diving capabilities and long submergence times reduce the probability that observers could spot them during marine surveys. One leatherback sea turtle was observed along the Hawaiian shoreline during monitoring surveys in 2006 (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013).

Leatherback sea turtles are regularly seen off the western coast of the United States, with the greatest densities found in waters off of central California. Off central California, sea surface temperatures are highest during the summer and fall. These warmer temperatures and other oceanographic conditions create favorable habitat for leatherback sea turtle prey (jellyfish). There is some evidence that they follow the 61°F (16°C) isotherm into Monterey Bay, and the length of their stay apparently depends on prey availability. Satellite telemetry studies link leatherback sea turtles off the U.S. West Coast to one of the two largest remaining Pacific Ocean breeding populations in Jamursba Medi, Indonesia. Thus, nearshore waters off central California represent an important foraging region for the critically endangered Pacific Ocean leatherback sea turtle. There were 96 sightings of leatherbacks within 50 kilometers of Monterey Bay from 1986 to 1991, mostly by recreational boaters (Starbird et al., 1993).

3.8.2.2.5.3 Population Trends

Most stocks in the Pacific Ocean are faring poorly, where nesting populations have declined more than 80 percent since the 1980s, and because the threats to these subpopulations have not ceased, the International Union for Conservation of Nature has predicted a decline of 96 percent for the western Pacific subpopulation and a decline of nearly 100 percent for the eastern Pacific subpopulation by 2040 (Clark et al., 2010; National Marine Fisheries Service, 2016; Sarti-Martinez et al., 1996). In contrast, western Atlantic and South African populations are generally stable or increasing. Causes for this decline include the intensive egg harvest in Pacific leatherback rookeries and high levels of mortality through the 1980s associated with bycatch in Pacific gill net fisheries (Fisheries and Oceans Canada, 2016b; Florida Fish and Wildlife Conservation Commission, 2015).

3.8.2.2.5.4 Predator and Prey Interactions

Leatherbacks lack the crushing chewing plates characteristic of hard-shelled sea turtles that feed on hard-bodied prey. Instead, they have pointed tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied open-ocean prey such as jellyfish and salps. Leatherback sea turtles feed throughout the water column (Davenport, 1988; Eckert et al., 1989; Eisenberg & Frazier, 1983; Grant & Ferrell, 1993; James et al., 2005b; Salmon et al., 2004). Leatherback prey is predominantly jellyfish (Aki et al., 1994; Bjorndal, 1997; James & Herman, 2001; Salmon et al., 2004). Engelhaupt et al. (2016) conducted gastrointestinal analysis on two leatherbacks southeast of Hawaii and found 94 percent of stomach contents to be comprised of salps, the remaining portion were unidentifiable invertebrates.

Predators of leatherback nests are common to other sea turtle species (e.g., terrestrial mammals and invertebrates). Fais et al. (2015) found that nesting female leatherbacks expend a significant amount of time and energy, despite increased risk of direct predation while on land, to obscure nests. After laying nests and covering with sand, the female's return to the ocean is not linear, and is likely an attempt at decoy behavior as a further measure to protect the clutch. In the water, hatchlings are susceptible to predation by birds and fish. Sharks are the primary predator of juvenile and adult loggerhead sea turtles (National Marine Fisheries Service, 2016).

3.8.2.2.5.5 Species-Specific Threats

In addition to the general threats to sea turtles described previously, bycatch in commercial fisheries is a particular threat to leatherback sea turtles. Incidental capture in longline and coastal gillnet fisheries has caused a substantial number of leatherback sea turtle deaths, likely because leatherback sea turtles dive to depths targeted by longline fishermen and are less maneuverable than other sea turtle species. Natural factors, including the 2004 tsunami in the Indian Ocean and the tsunami that affected Japan in 2011, may have impacted leatherback nesting beach habitat through encroachment, erosion, or increased inundation with debris in leatherback foraging habitats and migratory routes (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2013). Eckert and Sarti-Martinez (1997) attributed the decline in the Mexican population of leatherbacks to the growth of the longline and coastal gillnet fisheries in the Pacific. Leatherbacks from this population migrate to the north Pacific and southeastern Pacific where these fisheries operate. Robinson et al. (2013) suggest that climate change impacts are contributing to the Pacific leatherback population declines through a shifting of nesting dates, which increases stressor exposure. Lastly, climate change may impact leatherback distribution because leatherback distributions are closely associated with jellyfish aggregations (which are affected by changing ocean temperatures and dynamics) (Pike, 2014).

3.8.2.3 Species Not Listed under the Endangered Species Act

The only marine reptile species in the Study Area not listed under the ESA is the yellow-bellied sea snake. This species is described in more detail in the following subsections.

3.8.2.3.1 Yellow-bellied Sea Snake (*Pelamis platura*)

3.8.2.3.1.1 Status and Management

This species is not managed under any international or U.S. regulatory framework.

3.8.2.3.1.2 Habitat and Geographic Range

The species is the most pelagic of all sea snakes, occurring in the open ocean well away from coasts and reefs. However, a small number of sea snakes wash ashore, are observed in coastal waters, or occur in inter-tidal habitats (Murphy, 2012). In the open ocean, yellow-bellied sea snakes often occur in large numbers associated with long lines of debris. These aggregations are associated with sea caves, nesting sites, or near drift lines in the open ocean. In some areas, such as the Gulf of Panama in the eastern Pacific Ocean, the aggregations can vary in width from 1 to 300 m and include up to 1,000 individuals (Brischoux et al., 2016; Cook et al., 2015).

The yellow-bellied sea snake is the most widely distributed species of marine sea snake, ranging from the Cape of Good Hope westward across the Indo-Pacific to the western coastline of Central America (Brischoux et al., 2016; Cook et al., 2015; Lillywhite et al., 2015). Because this sea snake species exhibits a passive drifting ecology, the yellow-bellied sea snake may be carried into regions where it does not maintain a resident breeding population (e.g., California, Hawaii, New Zealand, Tasmania, the Sea of Japan, and the Galapagos) (Lillywhite et al., 2015; Udyawer et al., 2013).

The strong El Niño conditions that developed throughout the Pacific in 2015 and 2016 likely caused changes in sea levels and living marine resources distributions (Milstein, 2015). Coupled with oceanic temperature warming trends, these factors are thought to facilitate sea snake occurrence in coastal waters of California.

3.8.2.3.1.3 Population Trends

Lillywhite et al. (2015) suspected that the pan-oceanic population of yellow-bellied sea snakes is exceptionally large compared to other snakes because of this species' wide range and given that aggregations number in the thousands at various locations. Estimating population size for this species is difficult, as the range is very broad over several oceans. This species, however, is fairly common throughout its known range. In addition, the distribution pattern of the yellow-bellied sea snake is very clumped. Visual surveys from boats are probably the most suitable technique for estimating population size when they occur in large aggregations associated with marine debris or from opportunistic sightings on boats or when they wash ashore (Brischoux et al., 2016; Lillywhite et al., 2014).

3.8.2.3.1.4 Predator and Prey Interactions

Yellow-bellied sea snakes are believed to prey exclusively on fish, primarily in pelagic environments (Cook et al., 2015; Lillywhite et al., 2014). As stated in Section 3.8.2.1.3 (Dive Behavior), yellow-bellied sea snakes likely make shallow dives (with average depths of approximately 11 m). Cook et al. (2015) implanted temperature-depth loggers on three other sea snake species in New Caledonia. Logging 1,850 dives, nearly all dives were less than 30 m deep. A maximum dive duration was approximately 124 minutes.

3.8.2.3.1.5 Species-Specific Threats

Squid trawlers may be a source of bycatch, but is this is thought to be a minor threat because of this species' preference for open pelagic habitats (Brischoux et al., 2016). Marine debris may also be a minor threat to this species. Udyawer et al. (2013) reported the entrapment of a sea snake (*Hydrophis elegans*) with a ceramic washer encircling its body. The authors of this study report that a post-mortem examination determined that the snake was malnourished because of the constriction.

3.8.3 Environmental Consequences

This section evaluates how, and to what degree, the activities described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions) potentially impact reptiles known to occur within the Study Area. Tables 2.6-1 through 2.6-5 present the baseline and proposed typical training and testing activity locations for each alternative (including number of events). General characteristics of all Navy stressors were introduced in Section 3.0.3.3 (Identifying Stressors for Analysis), and living resource's general susceptibilities to stressors were introduced in Section 3.0.3.6 (Biological Resource Methods). The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors analyzed for reptiles are:

- Acoustic (sonar and other transducers, air guns, pile driving, vessel noise, aircraft noise, weapon noise)
- Explosive (explosions in-air, explosions in-water)
- Energy (in-water electromagnetic devices, high-energy lasers)
- Physical disturbance and strikes (vessels and in-water devices, military expended materials, seafloor devices, pile driving)
- Entanglement (wires and cables, decelerators/parachutes, biodegradable polymers)
- Ingestion (military expended materials – munitions, military expended materials other than munitions)
- Secondary stressors (impacts on habitat; impacts on prey availability)

The analysis includes consideration of the mitigation that the Navy will implement to avoid or reduce potential impacts on sea turtles from acoustic, explosive, and physical disturbance and strike stressors. Mitigation was coordinated with NMFS through the consultation process. Details of the Navy's mitigation are provided in Chapter 5 (Mitigation).

3.8.3.1 Acoustic Stressors

The analysis of effects to reptiles follows the concepts outlined in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities). This section begins with a summary of relevant data regarding acoustic impacts on reptiles in Section 3.8.3.1.1 (Background). This is followed by an analysis of estimated impacts on reptiles due to specific Navy acoustic stressors (sonar and other transducers, air guns, pile driving, vessel noise, aircraft noise, weapon noise). Additional explanations of the acoustic terms and sound energy concepts used in this section are found in Appendix D (Acoustic and Explosive Concepts). Studies of the effects of sound on aquatic reptiles are limited; therefore, where necessary, knowledge of impacts on other species from acoustic stressors is used to assess impacts on sea turtles and sea snakes.

3.8.3.1.1 Background

The sections below include a survey and synthesis of best available science published in peer-reviewed journals, technical reports, and other scientific sources pertinent to impacts on reptiles potentially resulting from Navy training and testing activities. Reptiles could be exposed to a range of impacts depending on the sound source and context of the exposure. Exposures to sound-producing activities may result in auditory or non-auditory trauma, hearing loss resulting in temporary or permanent hearing threshold shift, auditory masking, physiological stress, or changes in behavior.

3.8.3.1.1.1 Injury

The high peak pressures close to some non-explosive impulsive underwater sound sources, such as air guns and impact pile driving, may be injurious, although there are no reported instances of injury to reptiles caused by these sources. A Working Group organized under the American National Standards Institute-Accredited Standards Committee S3, Subcommittee 1, Animal Bioacoustics, developed sound exposure guidelines for fish and sea turtles (Popper et al., 2014), hereafter referred to as the *ANSI Sound Exposure Guidelines*. Lacking any data on non-auditory sea turtle injuries due to non-explosive impulsive sounds, such as pile driving and air guns, the working group conservatively recommended that non-auditory injury could be analyzed using data from fish. The data show that fish would be resilient to injury to the non-explosive impulsive sound sources analyzed in this EIS/OEIS. Therefore, it is assumed that sea turtles and sea snakes would be as well. Additionally, sea turtle shells may protect against non-auditory injury due to exposures to high peak pressures (Popper et al., 2014).

Lacking any data on non-auditory sea turtle injuries due to sonars, the working group also estimated the risk to sea turtles from low-frequency sonar to be low and mid-frequency sonar to be non-existent. Due to similarity in hearing, it is assumed that this would be the case for sea snakes as well.

As discussed in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities, specifically Section 3.0.3.6.1.1, Injury), mechanisms for non-auditory injury due to acoustic exposure have been hypothesized for diving breath-hold animals.

Acoustically induced bubble formation, rectified diffusion, and acoustic resonance of air cavities are considered for their similarity to pathologies observed in marine mammals stranded coincident with sonar exposures but were found to not be likely causal mechanisms (Section 3.7.3.1.1.1, Injury), and findings are applicable to reptiles.

Nitrogen decompression due to modifications to dive behavior has never been observed in sea turtles. Sea turtles are thought to deal with nitrogen loads in their blood and other tissues, caused by gas exchange from the lungs under conditions of high ambient pressure during diving, through anatomical, behavioral, and physiological adaptations (Lutcavage & Lutz, 1997). Although diving sea turtles experience gas supersaturation, gas embolism has only been observed in sea turtles bycaught in fisheries (Garcia-Parraga et al., 2014). Therefore, nitrogen decompression due to changes in diving behavior is not considered a potential consequence to diving reptiles.

3.8.3.1.1.2 Hearing Loss and Auditory Injury

Exposure to intense sound may result in hearing loss, typically quantified as threshold shift, which persists after cessation of the noise exposure. Threshold shift is a loss of hearing sensitivity at an affected frequency of hearing. This noise-induced hearing loss may manifest as temporary threshold shift (TTS), if hearing thresholds recover over time, or permanent threshold shift (PTS), if hearing thresholds do not recover to pre-exposure thresholds. Because studies on inducing threshold shift in reptiles are very limited (e.g., alligator lizards: Dew et al., 1993; Henry & Mulroy, 1995), are not sufficient to estimate TTS and PTS onset thresholds, and have not been conducted on any of the reptiles present in the Study Area, auditory threshold shift in reptiles is considered to be consistent with general knowledge about noise-induced hearing loss described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

Because there are no data on auditory effects on sea turtles, the *ANSI Sound Exposure Guidelines* (Popper et al., 2014) do not include numeric sound exposure thresholds for auditory effects on sea turtles. Rather, the guidelines qualitatively estimate that sea turtles are less likely to incur TTS or PTS with increasing distance from various sound sources. The guidelines also suggest that data from fishes may be more relevant than data from marine mammals when estimating impacts on sea turtles, because, in general, fish hearing range is more similar to the limited hearing range of sea turtles. As shown in Section 3.8.2.1.4.1 (Hearing and Vocalization – Sea Turtles), sea turtle hearing is most sensitive around 100 to 400 Hz in-water, is limited over 1 kilohertz (kHz), and is much less sensitive than that of any marine mammal. Therefore, sound exposures from most mid-frequency and all high-frequency sound sources are not anticipated to affect sea turtle hearing, and sea turtles are likely only susceptible to auditory impacts when exposed to very high levels of sound within their limited hearing range.

Sea snake hearing is also suspected to be limited to very low frequencies (below 1 kHz), as described in Section 3.8.2.1.4.2 (Hearing and Vocalization – Sea Snakes). It is assumed that sea snake susceptibility to auditory impacts would be similar to that of sea turtles.

3.8.3.1.1.3 Physiological Stress

A stress response is a suite of physiological changes meant to help an organism mitigate the impact of a stressor. If the magnitude and duration of the stress response is too great or too long, then it can have negative consequences to the animal (e.g., decreased immune function, decreased reproduction). Physiological stress is typically analyzed by measuring stress hormones, other biochemical markers, or vital signs. Physiological stress has been measured for sea turtles during nesting (Flower et al., 2015; Valverde et al., 1999), capture and handling (Flower et al., 2015; Gregory & Schmid, 2001), and when caught in entanglement nets (Hoopes et al., 2000; Snoddy et al., 2009) and trawls (Stabenau et al., 1991). However, the stress caused by acoustic exposure has not been studied for reptiles. Therefore, the stress response in reptiles in the Study Area due to acoustic exposures is considered to be consistent with general knowledge about physiological stress responses described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

Marine animals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with members of the same species, nesting, and interactions with predators all contribute to stress. Anthropogenic sound-producing activities have the potential to provide additional stressors beyond those that naturally occur.

Due to the limited information about acoustically induced stress responses, the Navy conservatively assumes in its effects analysis that any physiological response (e.g., hearing loss or injury) or significant behavioral response is also associated with a stress response.

3.8.3.1.1.4 Masking

As described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), auditory masking occurs when one sound, distinguished as the "noise," interferes with the detection or recognition of another sound or limits the distance over which other biologically relevant sounds, including those produced by prey, predators, or conspecifics, can be detected. Masking only occurs when the sound source is operating; therefore, direct masking effects stop immediately upon cessation of the sound-producing activity. Any sound above ambient noise and within an animal's hearing range may potentially cause masking.

Compared to other marine animals, such as marine mammals that are highly adapted to use sound in the marine environment, marine reptile hearing is limited to lower frequencies and is less sensitive. Because marine reptiles likely use their hearing to detect broadband low-frequency sounds in their environment, the potential for masking would be limited to certain similar sound exposures. Only continuous human-generated sounds that have a significant low-frequency component, are not brief in duration, and are of sufficient received level would create a meaningful masking situation (e.g., vibratory pile extraction or proximate vessel noise). Other intermittent, short-duration sound sources with low-frequency components (e.g., air guns or low-frequency sonars) would have more limited potential for masking depending on the duty cycle.

There is evidence that reptiles may rely primarily on senses other than hearing for interacting with their environment, such as vision (Narazaki et al., 2013), magnetic orientation (Avens, 2003; Putman et al., 2015), and scent (Shine et al., 2004). Any effect of masking may be mediated by reliance on other environmental inputs.

3.8.3.1.1.5 Behavioral Reactions

Behavioral responses fall into two major categories: Alterations in natural behavior patterns and avoidance. These types of reactions are not mutually exclusive and reactions may be combinations of behaviors or a sequence of behaviors. As described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), the response of a reptile to an anthropogenic sound would likely depend on the frequency, duration, temporal pattern, and amplitude of the sound as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). Distance from the sound source and whether it is perceived as approaching or moving away may also affect the way a reptile responds to a sound.

Reptiles may detect sources below 2 kHz but have limited hearing ability above 1 kHz. They likely detect most broadband sources (including air guns, pile driving, and vessel noise) and low-frequency sonars, so they may respond to these sources. Because auditory abilities for sea turtles and sea snakes are poor above 1 kHz, detection and consequent reaction to any mid-frequency source is unlikely.

In the *ANSI Sound Exposure Guidelines* (Popper et al., 2014), qualitative risk factors were developed to assess the potential for sea turtles to respond to various underwater sound sources. The guidelines state that there is a low likelihood that sea turtles would respond within tens of meters of low-frequency sonars, and that it is highly unlikely that sea turtles would respond to mid-frequency sources. The risk that sea turtles would respond to other broadband sources, such as shipping, air guns, and pile driving, is considered high within tens of meters of the sound source, but moderate to low at farther distances. For this analysis, it is assumed that these guidelines would also apply to sea snakes.

Behavioral Reactions to Impulsive Sound Sources

There are limited studies of reptile responses to sounds from impulsive sound sources, and all data come from sea turtles exposed to seismic air guns. These exposures consist of multiple air gun shots, either in close proximity or over long durations, so it is likely that observed responses may overestimate responses to single or short-duration impulsive exposures. Studies of responses to air guns are used to inform reptile responses to other impulsive sounds (impact pile driving and some weapon noise).

O'Hara and Wilcox (1990) attempted to create a sound barrier at the end of a canal using seismic air guns. They reported that loggerhead sea turtles kept in a 300 m by 45 m enclosure in a 10 m deep canal maintained a minimum standoff range of 30 m from air guns fired simultaneously at intervals of 15 seconds with strongest sound components within the 25–1,000 Hz frequency range. McCauley et al. (2000) estimated that the received sound pressure level (SPL) at which turtles avoided sound in the O'Hara and Wilcox (1990) experiment was 175–176 dB re 1 µPa.

Moein Bartol et al. (1995) investigated the use of air guns to repel juvenile loggerhead sea turtles from hopper dredges. Sound frequencies of the air guns ranged from 100 to 1,000 Hz at three source SPLs: 175, 177, and 179 dB re 1 µPa at 1 m. The turtles avoided the air guns during the initial exposures (mean range of 24 m), but additional exposures on the same day and several days afterward did not elicit avoidance behavior that was statistically significant. They concluded that this was likely due to habituation.

McCauley et al. (2000) exposed a caged green and a caged loggerhead sea turtle to an approaching-departing single air gun to gauge behavioral responses. The trials showed that above a received SPL of 166 dB re 1 µPa, the turtles noticeably increased their swimming activity compared to nonoperational periods, with swimming time increasing as air gun SPLs increased during approach. Above 175 dB re

1 µPa, behavior became more erratic, possibly indicating the turtles were in an agitated state. The authors noted that the point at which the turtles showed more erratic behavior and exhibited possible agitation would be expected to approximate the point at which active avoidance to air guns would occur for unrestrained sea turtles.

No obvious avoidance reactions by free-ranging sea turtles, such as swimming away, were observed during a multi-month seismic survey using air gun arrays, although fewer sea turtles were observed when the seismic air guns were active than when they were inactive (Weir, 2007). The author noted that sea state and the time of day affected both air gun operations and sea turtle surface basking behavior, making it difficult to draw conclusions from the data. However, DeRuiter and Doukara (2012) noted several possible startle or avoidance reactions to a seismic air gun array in the Mediterranean by loggerhead sea turtles that had been motionlessly basking at the water surface.

Behavioral Reactions to Sonar and Other Transducers

Studies of reptile responses to non-impulsive sounds are limited. All data are from studies with sea turtles. Lenhardt (1994) used very low frequency vibrations (< 100 Hz) coupled to a shallow tank to elicit swimming behavior responses by two loggerhead sea turtles. Watwood et al. (2016) tagged green sea turtles with acoustic transponders and monitored them using acoustic telemetry arrays in Port Canaveral, FL. Sea turtles were monitored before, during, and after a routine pierside submarine sonar test that utilized typical source levels, signals, and duty cycle. No significant long-term displacement was exhibited by the sea turtles in this study. The authors note that Port Canaveral is an urban marine habitat and that resident sea turtles may be less likely to respond than naïve populations.

3.8.3.1.1.6 Long-Term Consequences

For the reptiles present in the Study Area, long-term consequences to individuals and populations due to acoustic exposures have not been studied. Therefore, long-term consequences to reptiles due to acoustic exposures are considered following Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

The long-term consequences due to individual behavioral reactions and short-term (seconds to minutes) instances of physiological stress are especially difficult to predict because individual experience over time can create complex contingencies. 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 exposures to multiple stressors over significant periods of time. Conversely, some reptiles may habituate to or become tolerant of repeated acoustic exposures over time, learning to ignore a stimulus that in the past did not accompany any overt threat. For example, loggerhead sea turtles exposed to air guns with a source SPL of 179 dB re 1 µPa initially exhibited avoidance reactions. However, they may have habituated to the sound source after multiple exposures since a habituation behavior was retained when exposures were separated by several days (Moein Bartol et al., 1995). Intermittent exposures are assumed to be less likely to have lasting consequences.

3.8.3.1.2 Impacts from Sonar and Other Transducers

Sonar and other transducers emit sound waves into the water to detect objects, safely navigate, and communicate. Use of sonar and other transducers would typically be transient and temporary. General categories of sonar systems are described in Section 3.0.3.3.1 (Acoustic Stressors); only those sources within the hearing range of reptiles (<2 kHz) in the Study Area are considered.

Sonar-induced acoustic resonance and bubble formation phenomena are very unlikely to occur under realistic conditions, as discussed in Section 3.8.3.1.1.1 (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 3.8.3.1.1.2, Hearing Loss and Auditory Injury; 3.8.3.1.1.3, Physiological Stress; 3.8.3.1.1.4, Masking; and 3.8.3.1.1.5, Behavioral Reactions).

Impacts on sea turtles due to sonars and other transducers are considered throughout the Study Area. Impacts on sea snakes in the Southern California portion of the Study Area are not considered because their presence is extralimital; however, impacts are considered on sea snakes that may be present in the Hawaii Range Complex and the Transit Corridor.

3.8.3.1.2.1 Methods for Analyzing Impacts from Sonar and Other Transducers

Potential impacts considered are hearing loss due to threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, and changes in behavior. The Navy performed a quantitative analysis to estimate the number of times that sea turtles could be affected by sonars and other transducers used during Navy training and testing activities. The Navy's quantitative analysis to determine impacts on sea turtles and marine mammals uses the Navy Acoustic Effects Model to produce initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. 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 and spatial distribution of sea turtles; and
- the influence of environmental parameters (e.g., temperature, depth, salinity) on sound propagation when estimating the received sound level on the animals.

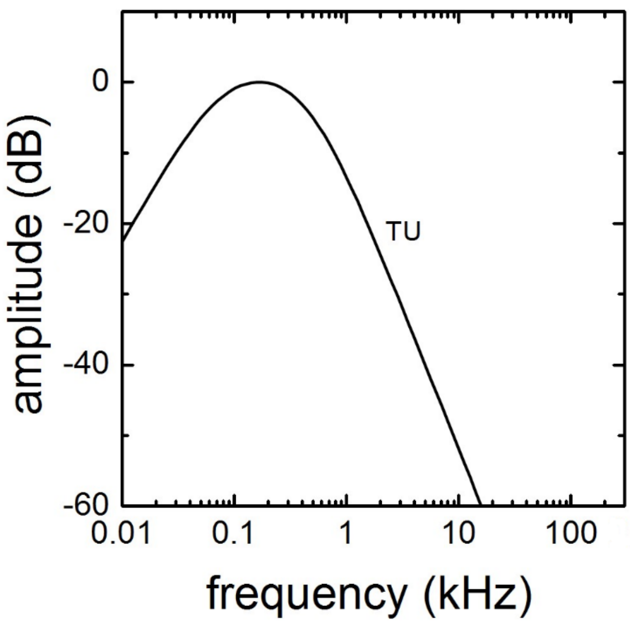
A further detailed explanation of this analysis is provided in the technical report, *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* **(U.S. Department of the Navy, 2017c)**.

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

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. 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. The adjusted received sound level is referred to as a weighted received sound level.

The auditory weighting function for sea turtles is shown in Figure 3.8-4. The derivation of this weighting function is described in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017a). The frequencies around the top portion of the function, where the amplitude is closest to zero, are emphasized, while the frequencies below and above this range (where amplitude declines) are de-emphasized, when summing acoustic energy received by a sea turtle.



Source: U.S. Department of the Navy (2017a)

Figure 3.8-4: Auditory Weighting Function for Sea Turtles

Notes: dB = decibels, kHz = kilohertz, TU = sea turtle species group

Hearing Loss from Sonar and Other Transducers

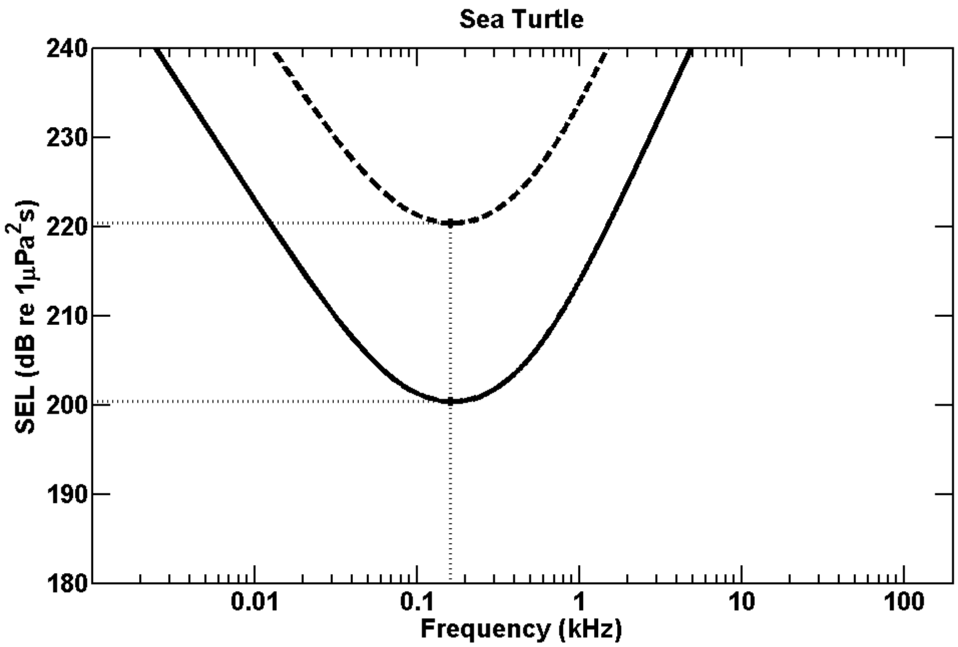
No studies of hearing loss have been conducted on sea turtles. Therefore, sea turtle susceptibility to hearing loss due to an acoustic exposure is evaluated using knowledge about sea turtle hearing abilities in combination with non-impulsive auditory effect data from other species (marine mammals and fish).

This yields sea turtle exposure functions, shown in Figure 3.8-5, which are mathematical functions that relate the sound exposure levels (SELs) for onset of TTS or PTS to the frequency of the sonar sound exposure. The derivation of the sea turtle exposure functions 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, 2017a).

Accounting for Mitigation

The Navy will implement mitigation measures to avoid or reduce potential impacts from active sonar on sea turtles, 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 sea turtle is observed in a mitigation zone. The mitigation zones for active sonar activities were designed to avoid the potential for sea turtles 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 encompass the estimated ranges to injury (including PTS) for a given sonar exposure. Therefore, the impact analysis quantifies the potential for mitigation to reduce the risk of PTS. 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., 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, 2017c).



Source: (U.S. Department of the Navy, 2017a)

Figure 3.8-5: TTS and PTS Exposure Functions for Sonar and Other Transducers

Notes: dB re 1 μPa²s: decibels referenced to 1 micropascal second squared, kHz = kilohertz. The solid black curve is the exposure function for TTS and the dashed black curve is the exposure function for PTS onset. Small dashed lines and asterisks indicate the SEL thresholds at the most sensitive frequency for TTS (200 dB) and PTS (220 dB).

In the quantitative analysis, consideration of mitigation measures means that, for activities where mitigation is feasible, some model-estimated PTS is considered mitigated to the level of TTS. The impact analysis does not analyze 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 range to PTS was estimated for each training or testing event. The ability of Navy Lookouts to detect sea turtles in or approaching the mitigation zone is dependent on the animal's presence at the surface and the characteristics of the animal that influence its sightability (such as size or surface active behavior). The behaviors and characteristics of some species may make them easier to detect. Environmental conditions under which the training or testing activity could take place are also considered, such as the sea surface conditions, weather (e.g., fog or rain), and day versus night.

3.8.3.1.2.2 Impact Ranges for Sonar and Other Transducers

Because sea turtle hearing range is limited to a narrow range of frequencies and thresholds for auditory impacts are relatively high, there are few sonar sources that could result in exposures exceeding the sea turtle TTS and PTS thresholds. Therefore, the range to auditory effects for most sources, such as the representative bin of LF5, in sea turtle hearing range is zero. Ranges would be greater (i.e., up to tens of meters) for sonars and other transducers with higher source levels; however, specific ranges cannot be provided in an unclassified document.

Ranges to auditory effects are not calculated for sea snakes. Due to similarity in hearing and for purposes of this analysis, sea snakes are assumed to have similar ranges to auditory impacts as sea turtles.

3.8.3.1.2.3 Impacts from Sonar and Other Transducers Under Alternative 1

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

General categories and characteristics of sonar systems and the number of hours these sonars would be operated during training under Alternative 1 are described in Section 3.0.3.3.1 (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 Activity Descriptions). Use of sonar and other transducers would typically be transient and temporary.

Under Alternative 1, the number of major training exercises and civilian port defense activities would fluctuate each year to account for the natural variation of training cycles and deployment schedules. Some unit-level anti-submarine warfare training requirements would be met through synthetic training in conjunction with other training exercises. Training activities using low-frequency sonar and other transducers within reptile hearing range (<2 kHz) could occur throughout the Study Area in areas potentially inhabited by sea turtles and sea snakes, although use would generally occur within 200 NM of shore in Navy operating areas, within Navy range complexes, on Navy testing ranges, or around inshore locations identified in Chapter 2 (Description of Proposed Action and Alternatives). The use of sources within reptile hearing range would be greater in the Southern California portion of the Study Area compared to the Hawaii Range Complex or the Transit Corridor. Density estimates of sea turtles inhabiting the Southern California portion of the Study Area include only green sea turtles in San Diego Bay, and these estimates do not exist for offshore areas where leatherback and loggerhead sea turtles could co-occur with anti-submarine warfare activities. Therefore, exposures were only modeled for green sea turtles in the San Diego Bay portion of the Southern California Range Complex and for green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles in the Hawaii Range Complex and Transit Corridor.

The quantitative analysis, using the number of hours of sonar and other transducers for a maximum year of training activities under Alternative 1, predicts that no sea turtles of any species are likely to be exposed to the high received levels of sound from sonars or other transducers that could cause TTS or PTS. Considering modeled and non-modeled species and activities, only a limited number of sonar and other transducers with frequencies within the range of reptile hearing (<2 kHz) and high source levels have the potential to cause TTS and PTS.

The *ANSI Sound Exposure Guidelines* estimate the risk of a sea turtle responding to a low-frequency sonar (less than 1 kHz) is low regardless of proximity to the source, and there is no risk of a sea turtle responding to a mid-frequency sonar (1–10 kHz) (Popper et al., 2014). A reptile could respond to sounds detected within its limited hearing range if it is close enough to the source. The few studies of sea turtle reactions to sounds, discussed in Section 3.8.3.1.1.5 (Behavioral Reactions), suggest that a behavioral response could consist of temporary avoidance, increased swim speed, or changes in depth, or that there may be no observable response. Use of sonar and other transducers would typically be transient and temporary, and there is no evidence to suggest that any behavioral response would persist after a sound exposure. It is assumed that a stress response could accompany any behavioral response.

Implementation of mitigation may further reduce the already low risk of auditory impacts on sea turtles. Depending on the sonar source, mitigation includes powering down the sonar or ceasing active sonar transmission if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

Although masking of biologically relevant sounds by the limited number of sonars and other transducers operated in reptile hearing range is possible, this may only occur in certain circumstances. reptiles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. The use characteristics of most low-frequency sonars, including limited band width, beam directionality, limited beam width, relatively low source levels, low duty cycle, and limited duration of use, would both greatly limit the potential for a sea turtle to detect these sources and limit the potential for masking of broadband, continuous environmental sounds. In addition, broadband sources within reptiles hearing range, such as countermeasures used during anti-submarine warfare, would typically be used in off-shore areas, not in near-shore areas where detection of beaches or concentrated vessel traffic is relevant for the masking of biologically relevant sounds to reptiles.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected. It is reasonable to assume that sea snakes use their hearing similarly to sea turtles and that any impacts on sea snakes would be similar to the types of impacts described for sea turtles.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with sonar and other transducers during training activities.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. 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

General categories and characteristics of sonar systems and the number of hours these sonars would be operated during testing under Alternative 1 are described in Section 3.0.3.3.1 (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 Activity Descriptions).

Under Alternative 1, the number of testing activities would fluctuate annually. Testing activities using sonar and other transducers could occur throughout the Study Area, although use of sources within reptile hearing range would be greater in the Southern California portion of the Study Area compared to the Hawaii Range Complex or the Transit Corridor. Density estimates of sea turtles inhabiting the Southern California portion of the Study Area include only green sea turtles in San Diego Bay, and these estimates do not exist for offshore areas where leatherback and loggerhead sea turtles could co-occur with anti-submarine warfare activities. Therefore, exposures were only modeled for green sea turtles in the San Diego Bay portion of the Southern California Range Complex and for green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles in the Hawaii Range Complex and Transit Corridor. Although the general impacts from sonar and other transducers under testing would be similar in severity to those described under training, there may be slightly more impacts under testing activities.

The quantitative analysis, using the number of hours of sonar and other transducers for a maximum year of testing activities, predicts that no sea turtles of any species are likely to be exposed to the high received levels of sound from sonars or other transducers that could cause TTS or PTS under Alternative 1. Considering modeled and non-modeled species and activities, only a limited number of sonars and other transducers with frequencies within the range of sea turtles hearing (<2 kHz) and high source levels have the potential to cause TTS and PTS. Any impact on hearing could reduce the distance over which a reptile detects environmental cues, such as the sound of waves or the presence of a vessel or predator.

The *ANSI Sound Exposure Guidelines* estimate the risk of a sea turtle responding to a low-frequency sonar (less than 1 kHz) is low regardless of proximity to the source, and there is no risk of a sea turtle responding to a mid-frequency sonar (1–10 kHz) (Popper et al., 2014). A reptile could respond to sounds detected within its limited hearing range if it is close enough to the source. The few studies of sea turtle reactions to sounds, discussed in Section 3.8.3.1.1.5 (Behavioral Reactions), suggest that a behavioral response could consist of temporary avoidance, increased swim speed, or changes in depth, or that there may be no observable response. Use of sonar and other transducers would typically be transient and temporary. There is no evidence to suggest that any behavioral response would persist after a sound exposure. It is assumed that a stress response could accompany any behavioral responses.

Implementation of mitigation may further reduce the already low risk of auditory impacts on sea turtles. Depending on the sonar source, mitigation includes powering down the sonar or ceasing active sonar transmission if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

Although masking of biologically relevant sounds by the limited number of sonars and other transducers operated in reptile hearing range is possible, this may only occur in certain circumstances. Reptiles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. The use characteristics of most sonars, including limited band width, beam directionality, limited beam width, relatively low source levels, low duty cycle, and limited duration of use, would both greatly limit the potential for a sea turtle to detect these sources and limit the potential for masking of broadband, continuous environmental sounds. In addition, broadband sources within sea turtle hearing range, such as countermeasures used during anti-submarine warfare, would typically be used in off-shore areas, not in nearshore areas where detection of beaches or concentrated vessel traffic is relevant.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected. It is reasonable to assume that sea snakes use their hearing similarly to sea turtles and that any impacts on sea snakes would be similar to the types of impacts described for sea turtles.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with sonar and other transducers during testing activities.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.1.2.4 Impacts from Sonar and Other Transducers Under Alternative 2

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

General categories and characteristics of sonar systems and the number of hours these sonars would be operated during training under Alternative 2 are described in Section 3.0.3.3.1 (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 Activity Descriptions).

Under Alternative 2, the maximum number of major training activities could occur every year, and only the number of civilian port defense activities would fluctuate annually. In addition, all unit-level anti-submarine warfare tracking exercise–ship activities would be completed through individual events conducted at sea, rather than through leveraging other anti-submarine warfare training exercises or synthetically. This would result in an increase of sonar use compared to Alternative 1, including sources within reptile hearing range. Training activities using low-frequency sonar and other transducers within sea turtle hearing range (<2 kHz) could occur throughout the Study Area in areas potentially inhabited by sea turtles and sea snakes, although use would generally occur within 200 NM of shore in Navy operating areas, within Navy range complexes, on Navy testing ranges, or around inshore locations identified in Chapter 2 (Description of Proposed Action and Alternatives). The use of sources within reptile hearing range would be greater in the Southern California portion of the Study Area compared to the Hawaii Range Complex or the Transit Corridor. Density estimates of sea turtles inhabiting the Southern California portion of the Study Area include only green sea turtles in San Diego Bay, and these estimates do not exist for offshore areas where leatherback and loggerhead sea turtles could co-occur with anti-submarine warfare activities. Therefore, exposures were only modeled for green sea turtles in the San Diego Bay portion of the Southern California Range Complex and for green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles in the Hawaii Range Complex and Transit Corridor.

The quantitative analysis predicts that no sea turtles of any species are likely to be exposed to the high received levels of sound from sonars or other transducers that could cause TTS or PTS during a maximum year of training activities under Alternative 2. Although there would be an increase in sonar use compared to Alternative 1, the potential for and type of impacts on reptiles would be the similar as described above for training under Alternative 1. This is because reptiles are capable of detecting only a limited number of sonars due to their limited hearing range.

The *ANSI Sound Exposure Guidelines* estimate the risk of a sea turtle responding to a low-frequency sonar (less than 1 kHz) is low regardless of proximity to the source, and there is no risk of a sea turtle responding to a mid-frequency sonar (1 to 10 kHz) (Popper et al., 2014). A reptile could respond to sounds detected within their limited hearing range if they are close enough to the source. The few studies of sea turtle reactions to sounds, discussed in Section 3.8.3.1.1.5 (Behavioral Reactions), suggest that a behavioral response could consist of temporary avoidance, increased swim speed, or changes in depth, or that there may be no observable response. Use of sonar and other transducers would typically be transient and temporary, and there is no evidence to suggest that any behavioral response would persist after a sound exposure. It is assumed that a stress response could accompany any behavioral responses.

Implementation of mitigation may further reduce the already low risk of auditory impacts on sea turtles. Depending on the sonar source, mitigation includes powering down the sonar or ceasing active sonar transmission if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

Although masking of biologically relevant sounds by the limited number of sonars and other transducers operated in reptile hearing range is possible, this may only occur in certain circumstances. Reptiles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. The use characteristics of most low-frequency sonars, including limited band width, beam directionality, limited beam width, relatively low source levels, low duty cycle, and limited duration of use, would both greatly limit the potential for a reptile to detect these sources and limit the potential for masking of broadband, continuous environmental sounds.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected.

It is reasonable to assume that sea snakes use their hearing similarly to sea turtles and that any impacts on sea snakes would be similar to the types of impacts described for sea turtles.

Pursuant to the ESA, the use of sonar and other transducers during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

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

General categories and characteristics of sonar systems and the number of hours these sonars would be operated during testing under Alternative 2 are described in Section 3.0.3.3.1 (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 Activity Descriptions).

Under Alternative 2, the maximum number of nearly all testing activities would occur every year. This would result in an increase of sonar use compared to Alternative 1, including sources within reptile hearing range. Testing activities using sonar and other transducers could occur throughout the Study Area, but use of sources within reptile hearing range would be greater in the Southern California portion of the Study Area compared to the Hawaii Range Complex or the Transit Corridor. Density estimates of sea turtles inhabiting the Southern California portion of the Study Area include only green sea turtles in San Diego Bay, and these estimates do not exist for offshore areas where leatherback and loggerhead sea turtles could co-occur with anti-submarine warfare activities. Therefore, exposures were only modeled for green sea turtles in the San Diego Bay portion of the Southern California Range Complex and for green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles in the Hawaii Range Complex and Transit Corridor.

The quantitative analysis predicts that no sea turtles of any species are likely to be exposed to the high received levels of sound from sonars or other transducers that could cause TTS or PTS during a maximum year of testing activities under Alternative 2. Although there would be a minor increase in sonar use compared to Alternative 1, the potential for and type of impacts on reptiles would be similar, because reptiles are capable of detecting only a limited number of sonars due to their limited hearing range.

The *ANSI Sound Exposure Guidelines* estimate the risk of a sea turtle responding to a low-frequency sonar (less than 1 kHz) is low regardless of proximity to the source, and there is no risk of a sea turtle responding to a mid-frequency sonar (1–10 kHz) (Popper et al., 2014). A reptile could respond to sounds detected within their limited hearing range if they are close enough to the source. The few studies of sea turtle reactions to sounds, discussed in Section 3.8.3.1.1.5 (Behavioral Reactions), suggest that a behavioral response could consist of temporary avoidance, increased swim speed, or changes in depth, or that there may be no observable response. Use of sonar and other transducers would typically be transient and temporary, and there is no evidence to suggest that any behavioral response would persist after a sound exposure. It is assumed that a stress response could accompany any behavioral responses.

Implementation of mitigation may further reduce the already low risk of auditory impacts on sea turtles. Depending on the sonar source, mitigation includes powering down the sonar or ceasing active sonar transmission if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

Although masking of biologically relevant sounds by the limited number of sonars and other transducers operated in reptile hearing range is possible, this may only occur in certain circumstances. Reptiles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. The use characteristics of most low-frequency sonars, including limited band width, beam directionality, limited beam width, relatively low source levels, low duty cycle, and limited duration of use, would both greatly limit the potential for a reptile to detect these sources and limit the potential for masking of broadband, continuous environmental sounds.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected. It is reasonable to assume that sea snakes, the only other reptile potentially present in the Study Area, use their hearing similarly to sea turtles and that any impacts on sea snakes would be similar to the types of impacts described for sea turtles.

Pursuant to the ESA, the use of sonar and other transducers during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.8.3.1.2.5 Impacts from Sonar and Other Transducers Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various acoustic stressors (e.g. sonar and other transducers) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.1.3 Impacts from Air Guns

Air guns use bursts of pressurized air to create broadband, impulsive sounds. Any use of air guns would typically be transient and temporary. Section 3.0.3.3.1.2 (Air Guns) provides additional details on the use and acoustic characteristics of the small air guns used in these activities.

3.8.3.1.3.1 Methods for Analyzing Impacts from Air Guns

Potential impacts considered are hearing loss due to threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, and changes in behavior. The Navy's quantitative analysis to determine impacts on sea turtles and marine mammals uses the Navy Acoustic

Effects Model to produce initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. 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 air guns (see below);
- the density and spatial distribution of sea turtles; and
- the influence of environmental parameters (e.g., temperature, depth, salinity) on sound propagation when estimated the received sound level on the animals

A further 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, 2017c). Since sea snakes have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that sea snakes could react similarly to air guns as sea turtles.

<u>Criteria and Thresholds used to Predict Impacts on Sea Turtles from Air Guns</u>

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. The auditory weighting function for sea turtles presented above in Section 3.8.3.1.2.1 (Methods for Analyzing Impacts from Sonar and Other Transducers) is also used in the quantitative assessment of auditory impacts due to air guns.

Hearing Loss from Air Guns

No studies of hearing loss have been conducted on sea turtles. Therefore, sea turtle susceptibility to hearing loss due to an air gun exposure is evaluated using knowledge about sea turtle hearing abilities in combination with auditory effect data from other species (marine mammals and fish). This yields sea turtle exposure functions, shown in Figure 3.8-6, which are mathematical functions that relate the SELs for onset of TTS or PTS to the frequency of the underwater impulsive sound exposure. The derivation of the sea turtle impulsive exposure functions 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, 2017a).

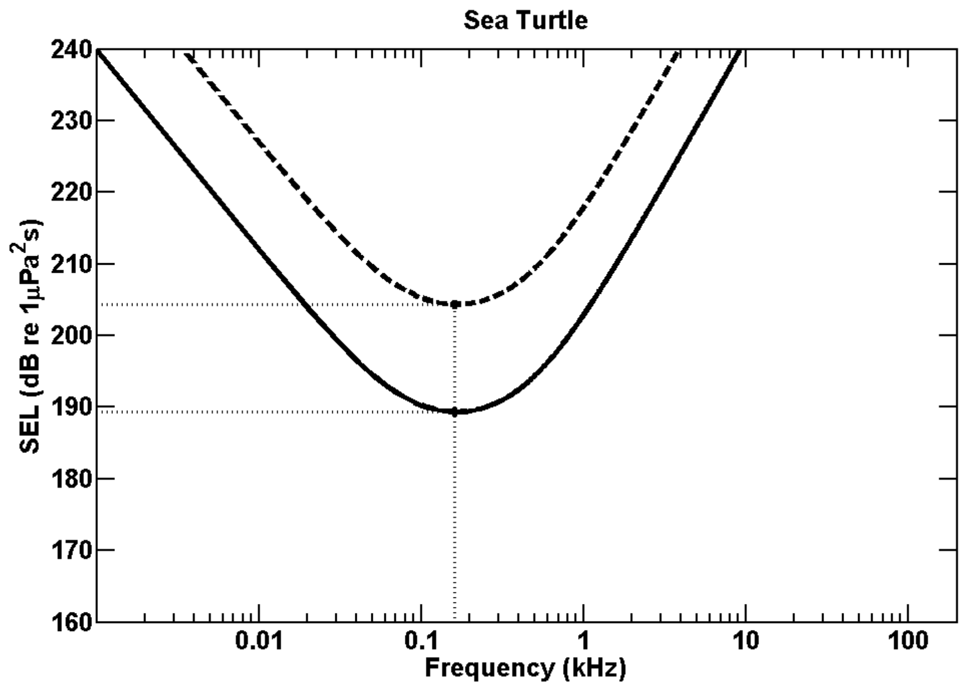


Figure 3.8-6: TTS and PTS Exposure Functions for Impulsive Sounds

Notes: 1. kHz = kilohertz, SEL = Sound Exposure Level, dB re 1 µPa2s = decibels referenced to 1 micropascal squared second. 2. The solid black curve is the exposure function for TTS onset and the dashed black curve is the exposure function for PTS onset. 3. Small dashed lines and asterisks indicate the SEL thresholds and most sensitive frequency for TTS and PTS.

For impulsive sounds, hearing loss in other species has also been observed to be related to the unweighted peak pressure of a received sound. Because this data does not exist for sea turtles, unweighted peak pressure thresholds for TTS and PTS were developed by applying relationships observed between impulsive peak pressure TTS thresholds and auditory sensitivity in marine mammals to sea turtles. This results in dual-metric hearing loss criteria for sea turtles for impulsive sound exposure: the SEL-based exposure functions in Figure 3.8-6 and the peak pressure thresholds in Table 3.8-2. The derivation of the sea turtle impulsive peak pressure TTS and PTS thresholds 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, 2017a).

Table 3.8-2: TTS and PTS Peak Pressure Thresholds for Sea Turtles Exposed to Impulsive Sounds

Auditory Effect	*Unweighted Peak Pressure Threshold*
TTS	226 dB re 1 µPa SPL peak
PTS	232 dB re 1 µPa SPL peak

Notes: dB re 1 µPa = decibels referenced to 1 micropascal, PTS = permanent threshold shift, TTS = temporary threshold shift, SPL = sound pressure level

3.8.3.1.3.2 Impact Ranges for Air Guns

Ranges to the onset of TTS or PTS for the air guns used in Navy activities are shown in Table 3.8-3. The majority of air gun activities occur offshore and involve the use of a single shot or 10 shots. The following ranges are based on the SEL metric for TTS and PTS for 10 firings of an air gun, a conservative estimate of the number of air gun firings that could occur over a single exposure duration at a single location. Ranges based on the peak pressure metric for TTS and PTS for 10 firings of an air gun, regardless of number of firings, are zero meters.

Table 3.8-3: Ranges to Permanent Threshold Shift and Temporary Threshold Shift for Sea Turtles Exposed to 10 Air Gun Firings

Range (m)	
TTS	***PTS***
10	1

3.8.3.1.3.3 Impacts from Air Guns Under Alternative 1

Impacts from Air Guns Under Alternative 1 for Training Activities

Training activities under Alternative 1 do not include the use of air guns.

Impacts from Air Guns Under Alternative 1 for Testing Activities

Characteristics of air guns and the number of times they would be operated during testing under Alternative 1 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities using air guns would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Under Alternative 1, small air guns (12–60 cubic inches) would typically be fired at off-shore locations in the Hawaii and Southern California Range Complexes.

These small air guns lack large pressures that could cause non-auditory injuries. The broadband impulsive sounds produced by these small air guns could only cause TTS and PTS for sea turtles within a short distance, as discussed in Section 3.8.3.1.3.2 (Impact Ranges for Air Guns). Considering that an air gun would be shut down if a sea turtle were sighted in the mitigation zone as described in Chapter 5 (Mitigation), any TTS is highly unlikely. The quantitative analysis, for a maximum year of air gun testing activities, predicts that no sea turtles of any species are likely to be exposed to the received levels of sound from air guns during testing activities, in their hearing range, that could cause TTS or PTS.

The working group that prepared the *ANSI Sound Exposure Guidelines* (Popper et al., 2014) provide parametric descriptors of sea turtle behavioral responses to air guns. Popper et al. (2014) estimate the risk of sea turtles responding to air guns is high, moderate, and low while at near (tens of meters), intermediate (hundreds of meters), and far (thousands of meters) distances from the source, respectively. Based on the few studies of sea turtle reactions to air guns, any behavioral reactions to air gun firings may be to increase swim speed or avoid the air gun. McCauley et al. (2000) estimated that sea turtles would begin to exhibit avoidance behavior when the received level of air gun firings was around 175 dB re 1 µPa, based on several studies of sea turtle exposures to air guns. The few studies of sea turtle reactions to sounds suggest that a behavioral response could consist of temporary avoidance, increased swim speed, or changes in depth, or that there may be no observable response. There is no evidence to suggest that any behavioral response would persist after a sound exposure. It is assumed that a stress response could accompany any behavioral responses.

Sea turtles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. Due to the low duration of an individual air gun shot, approximately 0.1 second, and the low duty cycle of sequential shots, the potential for masking from these small air guns would be low. Additionally, the use of small air guns in off-shore waters would not interfere with detection of sounds in inshore environments.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected. It is reasonable to assume that sea snakes use their hearing similarly to sea turtles and that any impacts on sea snakes would be similar to the types of impacts described for sea turtles.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with air guns during testing activities.

Pursuant to the ESA, the use of air guns during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.1.3.4 Impacts from Air Guns Under Alternative 2

Impacts from Air Guns Under Alternative 2 for Training Activities

Training activities under Alternative 2 do not include the use of air guns.

Impacts from Air Guns Under Alternative 2 for Testing Activities

The number and locations of air gun testing activities planned under Alternative 2 are identical to those planned under Alternative 1; therefore, the estimated impacts would be identical. Considering the factors discussed under Alternative 1 and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected. It is reasonable to assume that sea snakes use their hearing similarly to sea turtles and that any impacts on sea snakes would be similar to the types of impacts described for sea turtles.

Pursuant to the ESA, the use of air guns during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.8.3.1.3.5 Impacts from Air Guns Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various acoustic stressors (e.g. air guns) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.1.4 Impacts from Pile Driving

Sea turtles could be exposed to sounds from impact pile driving and vibratory pile extraction during the construction and removal phases of the elevated causeway system. This training activity involves the use of an impact hammer to drive 24-inch steel piles into the sediment to support an elevated causeway to the shore and a vibratory hammer to later remove the piles that support the causeway structure.

Section 3.0.3.3.1.3 (Pile Driving) provides additional details on pile driving activities and the noise levels measured from a prior elevated causeway installation and removal.

Sea snake occurrence in the Southern California portion of the Study Area, where pile driving activities take place, is considered extralimital. Therefore, the remainder of the analysis of effects from pile driving focuses on sea turtles.

3.8.3.1.4.1 Methods for Analyzing Impacts from Pile Driving

Potential impacts considered are hearing loss due to threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, and changes in behavior.

The Navy's quantitative analysis to determine impacts on sea turtles and marine mammals for pile driving produces initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. 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 pile driving (see below); and
- the density and spatial distribution of sea turtles.

A further 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, 2017c).

<u>Criteria and Thresholds used to Predict Impacts on Sea Turtles from Pile Driving</u>

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. The auditory weighting function for sea turtles presented above in Section 3.8.3.1.2.1 (Methods for Analyzing Impacts from Sonar and Other Transducers) is also used in the quantitative assessment of auditory impacts due to pile driving.

Hearing Loss from Pile Driving

Because impact pile driving produces impulsive noise, the criteria used to assess the onset of TTS and PTS are identical to those used for air guns, as described in Section 3.8.3.1.3.1 (Methods for Analyzing Impacts from Air Guns).

Because vibratory pile extraction produces continuous, non-impulsive noise, the criteria used to assess the onset of TTS and PTS due to exposure to sonars are used to assess auditory impacts on sea turtles, as described in Section 3.8.3.1.2.1 (Methods for Analyzing Impacts from Sonar and Other Transducers).

<u>Modeling of Pile Driving Noise</u>

Underwater noise effects from pile driving and vibratory pile extraction were modeled using actual measures of impact pile driving and vibratory removal during construction of an elevated causeway (Illingworth and Rodkin, 2015, 2017). A conservative estimate of spreading loss of sound in shallow coastal waters (i.e., transmission loss = $16.5*\text{Log}_{10}$[radius]) was applied based on spreading loss observed in actual measurements. Inputs used in the model are provided in Section 3.0.3.3.1.3 (Pile Driving), including source levels, the number of strikes required to drive a pile and the duration of vibratory removal for a pile, the number of piles driven or removed per day, and the number of days of pile driving and removal.

3.8.3.1.4.2 Impact Ranges for Pile Driving

The ranges to the onset of TTS and PTS for sea turtles exposed to impact pile driving are shown in Table 3.8-4. The ranges to effect are short due to sea turtles' relatively high thresholds for any auditory impacts compared to the source levels of impact pile driving conducted during Navy training.

Table 3.8-4: Ranges to TTS and PTS for Sea Turtles Exposed to Impact Pile Driving

Type of Activity	*PTS (m)*	*TTS (m)*
Impact Pile Driving (single pile)	2	19

Notes: TTS = temporary threshold shift, PTS = permanent threshold shift. Calculations for ranges to TTS and PTS assume a sound exposure level accumulated over a duration of one minute, after which time an animal is assumed to avoid the immediate area.

Because vibratory pile extraction has a low source level, it is not possible for a sea turtle to experience TTS or PTS, even if exposed to a full day of pile removal.

3.8.3.1.4.3 Impacts from Pile Driving Under Alternative 1

<u>Impacts from Pile Driving Under Alternative 1 for Training Activities</u>

Characteristics of pile driving (impact and vibratory extraction) and the number of times pile driving for the elevated causeway system would occur during training under Alternative 1 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities with pile driving would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Pile driving would take place nearshore and within the surf zone, up to two times per year at either the Silver Strand portion of the Southern California Range Complex in San Diego, California, or Marine Corps Base Camp Pendleton, California. Only green sea turtles are expected to be rarely in the vicinity of this coastal activity.

Impulses from the impact hammer strikes are broadband, within the hearing range of sea turtles, and carry most of their energy in the lower frequencies. The impulse from impact pile driving can also travel through the bottom sediment. The quantitative analysis, for a maximum duration of pile driving during training activities, predicts that no sea turtles of any species are likely to be exposed to the received levels of sound, in their hearing range, that could cause TTS or PTS.

The resident sub-population of green sea turtles residing in the San Diego Bay are unlikely to transit through potential pile driving areas, minimizing the chances of overlap between pile driving and green sea turtles. The impulse from impact pile driving can also travel through the bottom sediment, potentially disturbing sea turtles that may be present near the bottom. The low risk of impacts on sea turtles would be further reduced by soft starts. As discussed in Section 2.3.3.1.13 (Pile Driving Safety), as a standard operating procedure, the Navy performs soft starts at reduced energy during an initial set of strikes from an impact hammer. Soft starts may "warn" sea turtles and cause them to move away from the sound source before impact pile driving increases to full operating capacity. Soft starts were not considered when calculating the number of sea turtles that could be impacted, nor was the possibility that a sea turtle would avoid the construction area.

Sound produced from a vibratory hammer is broadband, continuous noise that is produced at a much lower level than impact driving. The quantitative analysis estimates that no sea turtles could be exposed to levels of vibratory pile extraction that could cause TTS or PTS. To further avoid the potential for impacts, the Navy will implement mitigation for pile driving that includes ceasing impact pile driving and vibratory pile extraction if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

The working group that prepared the *ANSI Sound Exposure Guidelines* (Popper et al., 2014) provide parametric descriptors of sea turtle behavioral responses to impact pile driving. Popper et al. (2014) estimate the risk of sea turtles responding to impact pile driving is high, moderate, and low while at near (tens of meters), intermediate (hundreds of meters), and far (thousands of meters) distances from the source, respectively. Based on prior observations of sea turtle reactions to sound, if a behavioral reaction were to occur, the responses could include increases in swim speed, change of position in the water column, or avoidance of the sound. There is no evidence to suggest that any behavioral response would persist beyond the sound exposure. It is assumed that a stress response could accompany any behavioral responses or TTS.

Sea turtles most likely use sound to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach. Despite the short duration of each impulse from an impact pile driving strike, the rate of impulses has the potential to result in some auditory masking of shore sounds or broadband vessel noise for sea turtles. Vibratory pile extraction is more likely than impact pile driving to cause masking of continuous broadband environmental sounds; however, due to its low source level, the masking effect would only be relevant in a small area around the vibratory pile extraction activity. These coastal areas tend to have high ambient noise levels due to natural and anthropogenic sources. For both types of activities, masking would only occur during the brief periods of time during which pile driving or removal is actively occurring, approximately less than two hours per day for two weeks in any year.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected. Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with pile driving during training activities.

Pursuant to the ESA, pile driving and removal during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat and would have no effect on hawksbill, olive ridley, loggerhead, and leatherback sea turtles, but may affect ESA-listed green sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Pile Driving Under Alternative 1 for Testing Activities

Testing activities under Alternative 1 do not include the use of pile driving (impact or vibratory).

3.8.3.1.4.4 Impacts from Pile Driving Under Alternative 2

Impacts from Pile Driving Under Alternative 2 for Training Activities

Pile driving training activities planned under Alternative 2 are identical to those planned under Alternative 1; therefore, the estimated impacts would be identical. Considering the factors described under Alternative 1 and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected. Pursuant to the ESA, pile driving and removal during training activities as described under

Alternative 2 would have no effect on leatherback sea turtle critical and would have no effect on hawksbill, olive ridley, loggerhead, and leatherback sea turtles, but may affect ESA-listed green sea turtles.

Impacts from Pile Driving Under Alternative 2 for Testing Activities

Testing activities under Alternative 2 do not include the use of pile driving (impact or vibratory).

3.8.3.1.4.5 Impacts from Pile Driving Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various acoustic stressors (e.g., pile driving) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.1.5 Impacts from Vessel Noise

The characteristics of noise produced by Navy vessels and their overall contribution to vessel noise in the Study Area are described in Section 3.0.3.3.1.4 (Vessel Noise) (Mintz & Filadelfo, 2011; Mintz, 2012). Navy ships makes up only 8 percent of total ship traffic in Hawaii, and only 4 percent of total ship traffic in Southern California (Mintz & Filadelfo, 2011; Mintz, 2016). In terms of anthropogenic noise, Navy ships would contribute a correspondingly smaller amount of vessel noise compared to commercial shipping and boating, which are more frequent (Mintz, 2012; Mintz & Filadelfo, 2011).

3.8.3.1.5.1 Methods for Analyzing Impacts from Vessel Noise

Potential impacts considered are masking of other biologically relevant sounds, physiological stress, and changes in behavior. The source levels of vessels are below the level of sound that would cause hearing loss for sea turtles. Due to their presumed similar hearing abilities, this likely applies to sea snakes as well.

There is little information on assessing behavioral responses of sea turtles to vessels. Sea turtles have been both observed to respond (DeRuiter & Doukara, 2012) and not respond (Weir, 2007) during seismic surveys, and any reaction could have been due to the active firing of air gun arrays, ship noise, ship presence, or some combination thereof. Lacking data that assesses sea turtle reactions solely to vessel noise, the *ANSI Sound Exposure Guidelines* (Popper et al., 2014) suggest that the relative risk of a sea turtle behaviorally responding to a continuous noise, such as vessel noise, is high when near a source (tens of meters), moderate when at an intermediate distance (hundreds of meters), and low at farther distances. These recommendations did not consider source level. While it is reasonable to assume that sea turtles may exhibit some behavioral response to vessels, numerous sea turtles bear scars that appear to have been caused by propeller cuts or collisions with vessel hulls (Hazel et al., 2007; Lutcavage & Lutz, 1997; Lutcavage et al., 1997) that may have been exacerbated by a sea turtle surfacing reaction or lack of reaction to vessels.

Since sea snakes have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that sea snakes would react similarly to vessel noise as sea turtles.

3.8.3.1.5.2 Impacts from Vessel Noise Under Alternative 1

Impacts from Vessel Noise Under Alternative 1 for Training Activities

Characteristics of vessel noise that would occur during training under Alternative 1 are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities with vessel noise would be conducted as described in

Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Vessel movements involve transits to and from ports to various locations within the Study Area, and many ongoing and proposed activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels), as well as unmanned vehicles. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to two weeks. Navy vessel traffic could occur anywhere within the Study Area, but would be concentrated near Navy ports such as San Diego and Pearl Harbor, and the Transit Corridor, which are heavily trafficked by private and commercial vessels, in addition to naval vessels. A study of Navy vessel traffic found that traffic was heaviest in the easternmost part of Southern California and in the area surrounding Honolulu (Mintz & Filadelfo, 2011; Mintz, 2012).

Surface combatant ships (e.g., destroyers, guided missile cruisers, and littoral combat ships) and submarines especially are designed to be quiet to evade enemy detection. Reptiles exposed to these Navy vessels may not respond at all or exhibit brief startle dive reactions, if, for example, basking on the surface near a passing vessel. Even for louder vessels, such as Navy oilers, it is not clear that reptiles would typically exhibit any reaction other than a brief startle and avoidance reaction, if they react at all. Any of these short-term (seconds to minutes) reactions to vessels are not likely to disrupt important behavioral patterns more than for a brief moment. The size and severity of these impacts would be insignificant and not rise to the level of measurable impacts.

Acoustic masking, especially from larger, non-combatant vessels, is possible. Vessels produce continuous broadband noise, with larger vessels producing sound that is dominant in the lower frequencies where reptile hearing is most sensitive, as described in Section 3.0.3.3.1.4 (Vessel Noise) (McKenna et al., 2012; Mintz & Filadelfo, 2011; Urick, 1983). Smaller vessels emit more energy in higher frequencies, much of which would not be detectable by reptiles. Sea turtles and sea snakes most likely use sound to detect nearby broadband, continuous low-frequency environmental sounds, such as the sounds of waves crashing on the beach, so vessel noise in those habitats may cause more meaningful masking. However, most vessel use would be in harbors or in transit to offshore areas, limiting masking impacts on sea turtles in many shore areas. Existing high ambient noise levels in ports and harbors with non-Navy vessel traffic and in shipping lanes with large commercial vessel traffic would limit the potential for masking by naval vessels in those areas. In offshore areas with lower ambient noise, the duration of any masking effects in a particular location would depend on the time in transit by a vessel through an area. Because sea turtles and sea snakes appear to rely on senses other than hearing for foraging and navigation, any impact of temporary masking is likely minor or inconsequential. Hazel et al. (2007) noted in one study that green sea turtles did not have time to react to vessels moving at speeds of about 10 knots, but reacted frequently to vessels at speeds of about two knots. Detection, therefore, was suggested to be based on the turtle's ability to see rather than hear an oncoming vessel.

Because impacts on individual reptiles, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any reptile populations.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with vessel noise from training activities.

Pursuant to the ESA, vessel noise during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Vessel Noise Under Alternative 1 for Testing Activities

Characteristics of Navy vessel noise are described in Section 3.0.3.3.1 (Acoustic Stressors). Activities with vessel noise would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Testing activities under Alternative 1 include vessel movement during many events. Because many testing activities would use the same or similar vessels as Navy training events, the general locations and types of effects due to vessel noise described above for training would be similar for many testing activities. Navy vessel noise would continue to be a minor contributor to overall radiated vessel noise in the exclusive economic zone.

Reptiles are likely able to detect low-frequency components of broadband continuous vessel noise, which may elicit masking, physiological stress, or behavioral reactions, including avoidance behavior. Because impacts on individual reptiles, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any reptile populations.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with vessel noise from testing activities.

Pursuant to the ESA, vessel noise during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.1.5.3 Impacts from Vessel Noise Under Alternative 2

Impacts from Vessel Noise Under Alternative 2 for Training Activities

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), training activities under Alternative 2 include vessel movement during many events. While there would be an increase in the amount of at-sea vessel time during training under Alternative 2, the general locations and types of effects due to vessel noise would be the same as described in Alternative 1. Navy vessel noise would continue to be a minor contributor to overall radiated vessel noise in the exclusive economic zone.

Reptiles are likely able to detect low-frequency components of broadband continuous vessel noise, which may elicit masking, physiological stress, or behavioral reactions, including avoidance behavior. The size and severity of these impacts would be insignificant and not rise to the level of measurable impacts. Because impacts on individual reptile, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any reptile populations.

Pursuant to the ESA, vessel noise during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Impacts from Vessel Noise Under Alternative 2 for Testing Activities

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), testing activities under Alternative 2 include vessel movement during many events. The difference in vessel noise contributed by testing activities under Alternative 2 compared to Alternative 1 is so small as to not be discernable.

Therefore, the general locations and types of effects due to vessel noise described above for testing under Alternative 1 would be the same under Alternative 2. Navy vessel noise would continue to be a minor contributor to overall radiated vessel noise in the exclusive economic zone.

Reptiles are likely able to detect low-frequency components of broadband continuous vessel noise, which may elicit masking, physiological stress, or behavioral reactions, including avoidance behavior. The size and severity of these impacts would be insignificant and not rise to the level of measurable impacts. Because impacts on individual reptiles, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any reptile populations.

Pursuant to the ESA, vessel noise during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.8.3.1.5.4 Impacts from Vessel Noise Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various acoustic stressors (e.g. vessel noise) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.1.6 Impacts from Aircraft Noise

Fixed, rotary-wing, and tilt-rotor aircraft are used during a variety of training and testing activities throughout the Study Area. Aircraft produce extensive airborne noise from either turbofan or turbojet engines. Rotary-wing aircraft (helicopters) produce low-frequency sound and vibration (Pepper et al., 2003). An infrequent type of aircraft noise is the sonic boom, produced when the aircraft exceeds the speed of sound. Fixed-wing aircraft would pass quickly overhead, while rotary-wing aircraft (e.g., helicopters) may hover at lower altitudes for longer durations. A description of aircraft noise produced during Navy activities is provided in Section 3.0.3.3.1.5 (Aircraft Noise), including estimates of underwater noise produced by certain flight activities.

Most in-air sound would be reflected at the air-water interface. Depending on atmospheric conditions, in-air sound can refract upwards, limiting the sound energy that reaches the water surface. This is especially true for sounds produced at higher altitudes. Underwater sounds from aircraft would be strongest just below the surface and directly under the aircraft. Any sound that does enter the water only does so within a narrow cone below the sound source that would move with the aircraft. For the common situation of a hovering helicopter, the sound pressure level in water would be about 125 dB re 1 µPa for an H-60 helicopter hovering at 50 ft. For an example fixed-wing flight, the sound pressure underwater would be about 128 dB re 1 µPa for an F/A-18 traveling at 250 knots at 3,000 ft. altitude. Most air combat maneuver activities would occur at higher altitudes. Supersonic aircraft, if flying at low altitudes, could generate an airborne sonic boom that may be sensed by reptiles at the surface, or as a low-level impulsive sound underwater.

3.8.3.1.6.1 Methods for Analyzing Impacts from Aircraft Noise

The amount of sound entering the ocean from aircraft would be very limited in duration, sound level, and affected area. For those reasons, impacts on sea turtles and other aquatic reptiles from aircraft have not been studied. Due to the low level of sound that could enter the water from aircraft, hearing loss is not further considered as a potential effect. Potential impacts considered are masking of other biologically relevant sounds, physiological stress, and changes in behavior.

There is little information on which to assess behavioral responses of sea turtles to aircraft. The *ANSI Sound Exposure Guidelines* for sea turtles did not consider this acoustic stressor (Popper et al., 2014). For this analysis, the Navy assumes that some animals at or near the water surface may exhibit startle reactions to certain aircraft noise if aircraft altitude is low. This could mean a hovering helicopter, for which the sight of the aircraft and water turbulence could also cause a response, or a low-flying or super-sonic aircraft generating enough noise to be briefly detectable underwater or at the air-water interface. Because any fixed-wing aircraft noise would be brief, the risk of masking any sounds relevant to reptiles is very low.

Since sea snakes have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that sea snakes would react similarly to aircraft noise as sea turtles.

3.8.3.1.6.2 Impacts from Aircraft Noise Under Alternative 1

Impacts from Aircraft Noise Under Alternative 1 for Training Activities

Characteristics of aircraft noise are described in Section 3.0.3.3.1 (Acoustic Stressors) and the number of training activities that include aircraft under Alternative 1 are shown in Section 3.0.3.3.4.4 (Aircraft). Training activities with aircraft would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Aircraft overflights would usually occur adjacent to Navy airfields, installations, and in special use airspace within Navy range complexes. In the Study Area, aircraft flights associated with training would be concentrated in the Southern California Range Complex compared to the Hawaii Range Complex and Transit Corridor.

Reptiles may respond to both the physical presence and to the noise generated by aircraft, making it difficult to attribute causation to one or the other stimulus. In addition to noise produced, all low-flying aircraft make shadows, which can cause animals at the surface to react. Helicopters may also produce strong downdrafts, a vertical flow of air that becomes a surface wind, which can also affect an animal's behavior at or near the surface.

In most cases, exposure of a reptile to fixed-wing presence and noise would be brief as the aircraft quickly passes overhead. Animals would have to be at or near the surface at the time of an overflight to be exposed to appreciable sound levels. Supersonic flight at-sea is typically conducted at altitudes exceeding 30,000 ft., limiting the number of occurrences of supersonic flight being audible at the water surface. Because most overflight exposures from fixed-wing aircraft or transiting helicopters would be brief and aircraft noise would be at low received levels, only startle reactions, if any, are expected in response to low altitude flights. Similarly, the brief duration of most overflight exposures would greatly limit any potential for masking of relevant sounds.

Daytime and nighttime activities involving helicopters may occur for extended periods of time, up to a couple of hours in some areas. During these activities, helicopters would typically transit throughout an area and may hover over the water. Longer activity durations and periods of time where helicopters hover may increase the potential for behavioral reactions, startle reactions, and physiological stress. Low-altitude flights of helicopters during some activities, which often occur under 100 ft. altitude, may elicit a stronger startle response due to the proximity of a helicopter to the water; the slower airspeed and therefore longer exposure duration; and the downdraft created by a helicopter's rotor.

Most fixed-wing aircraft and helicopter activities are transient in nature, although helicopters could also hover for extended periods. The likelihood that a reptile would occur or remain at the surface while an aircraft or helicopter transits directly overhead would be low. Helicopters that hover in a fixed location for an extended period of time could increase the potential for exposure. However, impacts from training activities would be highly localized and concentrated in space and duration.

Behavioral reactions, startle reactions, and physiological stress due to aircraft noise, including hovering helicopters, are likely to be brief (seconds to minutes) and minor, if they occur at all. Sea turtle reactions to aircraft noise have not been studied like marine mammals. For marine mammals, aircraft noise would cause only small temporary changes in behavior. Since reptile hearing is less sensitive than marine mammals, conservatively, it is likely that reptiles would exhibit temporary changes in behavior to aircraft noise as well. The size and severity of these impacts would be insignificant and not rise to the level of measurable impacts.

Because impacts on individual reptiles, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any reptile populations.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with aircraft noise from training activities.

Pursuant to the ESA, aircraft noise during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Aircraft Noise Under Alternative 1 for Testing Activities

Characteristics of aircraft noise are described in Section 3.0.3.3.1 (Acoustic Stressors) and the number of testing activities with aircraft under Alternative 1 are shown in Section 3.0.3.3.4.4. (Aircraft). Testing activities using aircraft would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). Aircraft overflights would usually occur near Navy airfields, installations, and in special use airspace within Navy range complexes.

Testing activities under Alternative 1 use aircraft during many events. Because many testing activities would use the same or similar aircraft as Navy training events, the general locations and types of effects due to aircraft noise described above for training would be similar for many testing activities. Because impacts on individual reptiles, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any reptile populations.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with aircraft noise from testing activities.

Pursuant to the ESA, aircraft noise during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.1.6.3 Impacts from Aircraft Noise Under Alternative 2

Impacts from Aircraft Noise Under Alternative 2 for Training Activities

There would be minor increase in aircraft noise under Alternative 2 compared to Alternative 1; however, the types of impacts would not be discernible from those described for training under Alternative 1. Because impacts on individual reptiles, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any reptile populations.

Pursuant to the ESA, aircraft noise during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Impacts from Aircraft Noise Under Alternative 2 for Testing Activities

There would be a minor increase in aircraft noise under Alternative 2 compared to Alternative 1; however, the types of impacts would not be discernible from those described for testing under Alternative 1. Because impacts on individual reptiles, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any reptile populations.

Pursuant to the ESA, aircraft noise during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.8.3.1.6.4 Impacts from Aircraft Noise Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various acoustic stressors (e.g., aircraft noise) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.1.7 Impacts from Weapons Noise

Reptiles may be exposed to sounds caused by the firing of weapons, objects in flight, and impact of non-explosive munitions on the water's surface, which are described in Section 3.0.3.3.1.6 (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 noise generated from firing a weapon include 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.

3.8.3.1.7.1 Methods for Analyzing Impacts from Weapons Noise

The amount of sound entering the ocean from weapons firing, projectile travel, and inert objects hitting the water would be very limited in duration and affected area. Sound levels could be relatively high directly beneath a gun blast, but even in the worst case scenario of a naval large caliber gun fired at the lowest elevation angle, sound levels in the water directly below the blast (about 200 db re 1 µPa SPL peak; see Yagla & Stiegler, 2003) are substantially lower than necessary to cause hearing loss in a sea turtle. Similarly, situations in which inert objects hitting the water, even at high speeds, could hypothetically generate sound sufficient to cause hearing loss within a short distance would be very rare. Therefore, hearing loss is not further considered as a potential effect. Potential impacts considered are masking of other biologically relevant sounds, physiological stress, and changes in behavior.

Since sea snakes have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that sea snakes would react similarly to weapons noise as sea turtles.

3.8.3.1.7.2 Impacts from Weapons Noise Under Alternative 1

Impacts from Weapons Noise Under Alternative 1 for Training Activities

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapons noise are described in Section 3.0.3.3.6 (Weapons Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for training under Alternative 1 are shown in Section 3.0.3.3.4.2 (Military Expended Materials). For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.8.3.2 (Explosive Stressors).

Activities would typically occur in the range complexes, with the greatest use of most types of munitions within 200 NM of the shore in the Hawaii and Southern California Range Complexes, and with fewer activities in the Transit Corridor. Most activities involving large-caliber naval gunfire or the launching of targets, missiles, bombs, or other munitions are conducted more than 12 NM from shore.

All of these sounds would be brief, lasting from less than a second for a blast or inert impact to a few seconds for other launch and object travel sounds. Most incidents of impulsive sounds produced by weapons firing, launch, or inert object impacts would be single events, with the exception of gunfire activities. It is expected that these sounds may elicit brief startle reactions or diving, with avoidance being more likely with the repeated exposure to sounds during gunfire events. It is assumed that, similar to air gun exposures, reptile behavioral responses would cease following the exposure event and the risk of a corresponding, sustained stress response would be low. Similarly, exposures to impulsive noise caused by these activities would be so brief that risk of masking relevant sounds would be low. These activities would not typically occur in nearshore habitats where sea turtles may use their limited hearing to sense broadband, coastal sounds. Behavioral reactions, startle reactions, and physiological stress due to weapons noise are likely to be brief and minor, if they occur at all due, to the low probability of co-occurrence between weapons activity and reptile individuals.

To further avoid the potential for impacts, the Navy will implement mitigation for weapons noise that includes ceasing large-caliber gunnery activities if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with weapons noise from training activities.

It is reasonable to assume that sea snakes use their hearing similarly to sea turtles and that the types of impacts would be similar to those described above for sea turtles. Because impacts on individual reptiles, if any, are expected to be minor and limited, long-term consequences to individuals or populations would not be expected.

Pursuant to the ESA, weapons noise during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Weapons Noise Under Alternative 1 for Testing Activities

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapons noise are described in Section 3.0.3.3.1.6 (Weapons Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment producing) for testing under Alternative 1 are shown in Section 3.0.3.3.4.2 (Military Expended Materials). For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.8.3.2 (Explosive Stressors).

The general types of effects due to weapon noise described above for training would be similar for many testing activities. Activities would typically occur in the range complexes, with the greatest use of most types of munitions within 200 NM of the shore in the Hawaii and Southern California Range Complexes, and with fewer activities in the Transit Corridor. Most activities involving large-caliber naval gunfire or the launching of targets, missiles, bombs, or other munitions are conducted more than 12 NM from shore.

To further avoid the potential for impacts, the Navy will implement mitigation for weapons firing noise that includes ceasing large-caliber gunnery activities if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), long-term consequences to sea turtle individuals or populations would not be expected. Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with weapons noise from testing activities.

It is reasonable to assume that sea snakes use their hearing similarly to sea turtles and that the types of impacts would be similar to those described above for sea turtles. Because impacts on individual reptiles, if any, are expected to be minor and limited, long-term consequences to individuals or populations would not be expected.

Pursuant to the ESA, weapons noise during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.1.7.3 Impacts from Weapons Noise Under Alternative 2

Impacts from Weapons Noise Under Alternative 2 for Training Activities

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapons noise are described in Section 3.0.3.3.1.6 (Weapons Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for training under Alternative 2 are shown in 3.0.3.3.4.2 (Military Expended Materials). For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.8.3.2 (Explosive Stressors).

There would be minor increase in these activities under Alternative 2 compared to Alternative 1; however, the types of impacts and locations of impacts would be the same as those described for training under Alternative 1. To further avoid the potential for impacts, the Navy will implement mitigation for weapons firing noise that includes ceasing large-caliber gunnery activities if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors).

Because impacts on individual reptiles, if any, are expected to be minor and limited, long-term consequences to individuals or populations are not expected.

Pursuant to the ESA, weapons noise during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Impacts from Weapons Noise Under Alternative 2 for Testing Activities

Activities using weapons and deterrents would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics of types of weapon noise are described in Section 3.0.3.3.1.6 (Weapons Noise), and quantities and locations of expended non-explosive practice munitions and explosives (fragment-producing) for testing under Alternative 2 are shown in 3.0.3.3.4.2 (Military Expended Materials). For explosive munitions, only associated firing noise is considered in the analysis of weapons noise. The noise produced by the detonation of explosive weapons is analyzed in Section 3.8.3.2 (Explosive Stressors).

There would be minor increase in these activities under Alternative 2 compared to Alternative 1; however, the types of impacts and locations of impacts would be the same as those described for testing under Alternative 1. To further avoid the potential for impacts, the Navy will implement mitigation for weapons noise that includes ceasing large-caliber gunnery activities if a sea turtle is observed in the mitigation zone, as discussed in Section 5.3.2 (Acoustic Stressors). Because impacts on individual reptiles, if any, are expected to be minor and limited, no long-term consequences to individuals are expected. Accordingly, there would be no consequences to any reptile populations.

Pursuant to the ESA, weapons noise during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.8.3.1.7.4 Impacts from Noise Under the No Action Alternative

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various acoustic stressors (e.g., weapons noise) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.2 Explosive Stressors

Explosions in the water or near the water surface can introduce loud, impulsive, broadband sounds into the marine environment. But, unlike other acoustic stressors, explosions release energy at a high rate producing a shock wave that can be injurious and even deadly. Therefore, explosive impacts on reptiles are discussed separately from other acoustic stressors, even though the analysis of explosive impacts will rely on data for sea turtle impacts due to impulsive sound exposure where appropriate.

Explosives are usually described by their net explosive weight, which accounts for the weight and type of explosive material. Additional explanation of the acoustic and explosive terms and sound energy concepts used in this section is found in Appendix D (Acoustic and Explosive Concepts).

This section begins with a summary of relevant data regarding explosive impacts on reptiles in Section 3.8.3.2.1 (Background). 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 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), and the analysis in this section follows that framework. Studies of the effects of sound and explosives on reptiles are limited; therefore, where necessary, knowledge of explosion impacts on other species from explosives is used to assess impacts on reptiles, such as sea turtles and sea snakes.

3.8.3.2.1 Background

The sections below include a survey and synthesis of best available science published in peer-reviewed journals, technical reports, and other scientific sources pertinent to impacts on reptiles potentially resulting from Navy training and testing activities. Reptiles could be exposed to a range of impacts depending on the explosive source and context of the exposure. In addition to acoustic impacts including temporary or permanent hearing loss, auditory masking, physiological stress, or changes in behavior; potential impacts from an explosive exposure can include non-lethal injury and mortality.

3.8.3.2.1.1 Injury

Because direct studies of explosive impacts on reptiles have not been conducted, the below discussion of injurious effects is based on studies of other animals, generally mammals. The generalizations that can be made about in-water explosive injuries to other species should be applicable to reptiles, with consideration of the unique anatomy of sea turtles. For example, it is unknown if the sea turtle shell may afford it some protection from internal injury.

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. However, rapid under-pressure caused by the negative surface-reflected pressure wave above an underwater detonation may create a zone of cavitation that may contribute to potential injury. In general, blast injury 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 Explosive Concepts) for an overview of explosive propagation and an explanation of explosive effects on gas cavities.

Primary blast injury is injury that results from the compression of a body exposed to a blast wave. This 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 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 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. In this discussion, primary blast injury to auditory tissues is considered gross structural tissue injury distinct from noise-induced hearing loss, which is considered below in Section 3.8.3.2.1.2 (Hearing Loss).

Data on observed injuries to sea turtles from explosions is generally limited to animals found following explosive removal of offshore structures (Viada et al., 2008), which can attract sea turtles for feeding opportunities or shelter. Klima et al. (1988) observed a turtle mortality subsequent to an oil platform removal blast, although sufficient information was not available to determine the animal's exposure. Klima et al. (1988) also placed small sea turtles (less than 7 kilograms) at varying distances from piling detonations. Some of the turtles were immediately knocked unconscious or exhibited vasodilation over the following weeks, but others at the same exposure distance exhibited no effects.

Incidental injuries to sea turtles due to military explosions have been documented in a few instances. In one incident, a single 1,200 pound (lb.) trinitrotoluene (TNT) underwater charge was detonated off Panama City, FL in 1981. The charge was detonated at a mid-water depth of 120 ft. Although details are limited, the following were recorded: at a distance of 500–700 ft., a 400 lb. sea turtle was killed; at 1,200 ft., a 200–300 lb. sea turtle experienced “minor” injury; and at 2,000 ft. a 200–300 lb. sea turtle was not injured (O'Keeffe & Young, 1984). In another incident, two “immature” green sea turtles (size unspecified) were found dead about 100-150 ft. away from detonation of 20 lb. of C-4 in a shallow water environment.

For this analysis, it is assumed that these types of observations would also apply to sea snakes. Results from limited experimental data suggest two explosive metrics are predictive of explosive injury: peak pressure and impulse.

Impulse as a Predictor of Explosive Injury

Without measurements of the explosive exposures in the above incidents, it is difficult to draw conclusions about what amount of explosive exposure would be injurious to aquatic reptiles. Studies of observed in-water explosive injuries showed that terrestrial mammals were more susceptible than comparably sized fish with swim bladders (Yelverton & Richmond, 1981), and that fish with swim bladders may have increased susceptibility to swim bladder oscillation injury depending on exposure geometry (Goertner, 1978; Wiley et al., 1981). Therefore, controlled tests with a variety of terrestrial mammals (mice, rats, dogs, pigs, sheep and other species) are the best available data sources on actual injury to similar-sized animals 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 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 principal damage sites in submerged terrestrial mammals, consistent with earlier studies of mammal exposures to underwater explosions (Clark & Ward, 1943; Greaves et al., 1943).

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 proportion of lung volume to overall body size is similar between sea turtles and terrestrial mammals, so the magnitude of lung damage in the tests may approximate the magnitude of injury to sea turtles when scaled for body size. Measurements of some shallower diving sea turtles (Hochscheid et al., 2007) show lung to body size ratios that are larger than terrestrial animals, whereas the lung to body mass ratio of the deeper diving leatherback sea turtle is smaller (Lutcavage et al., 1992). 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 kilograms) to underwater detonations, Richmond et al. (1973) reported that no blast injuries were observed when exposures were less than 6 lb. per square in. per millisecond (psi-ms) (40 pascal-seconds [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 adult sea turtles may be substantially larger and have respiratory structures adapted for the high pressures experienced at depth. Goertner (1982) examined how lung cavity size would affect susceptibility to blast injury by considering both size and depth in a bubble oscillation model of the lung, which is assumed to be applicable to reptiles as well for this analysis. 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 time 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. Based on a study of green sea turtles, Berkson (1967) predicted sea turtle lung collapse would be complete around 80–160 m depth.

Peak Pressure as a Predictor of Explosive Trauma

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 blasts generally describe peak pressure exposures around 100 lb. psi (237 dB re 1 µPa peak) to feel like a 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 1,147 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 explosions.

The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) recommended peak pressure guidelines for sea turtle injury from explosives. Lacking any direct data for sea turtles, these recommendations were based on fish data. Of the fish data available, the working group conservatively chose the study with the lowest peak pressures associated with fish mortality to set guidelines (Hubbs & Rechnitzer, 1952), and did not consider the Lovelace studies discussed above.

Fragmentation

Fragments produced by exploding munitions at or near the surface may present a high speed strike hazard for an animal at or near the surface. In water, however, fragmentation velocities decrease rapidly due to drag (Swisdak & Montaro, 1992). Because blast waves propagate efficiently through water, the range to injury from the blast wave would likely extend beyond the range of fragmentation risk.

3.8.3.2.1.2 Hearing Loss

An underwater explosion produces broadband, impulsive sound that can cause noise-induced hearing loss, typically quantified as threshold shift, which persists after cessation of the noise exposure. This noise-induced hearing loss may manifest as TTS or PTS. Because studies on inducing threshold shift in reptiles are very limited (e.g., alligator lizards: Dew et al. (1993); Henry and Mulroy (1995)) and have not been conducted on any of the reptiles present in the Study Area, auditory threshold shift in reptiles is considered to be consistent with general knowledge about noise-induced hearing loss described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

Little is known about how sea turtles or sea snakes use sound in their environment. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) do not suggest numeric sound exposure thresholds for auditory effects on sea turtles due to lack of data. Rather, the guidelines qualitatively advise that sea turtles are less likely to incur TTS or PTS with increasing distance from an explosion. The guidelines also suggest that data from fishes may be more relevant than data from marine mammals when estimating auditory impacts on sea turtles, because, in general, fish hearing range is more similar to the limited hearing range of sea turtles. As shown in Section 3.8.2.1.4.1 (Hearing and Vocalization – Sea Turtles), sea turtle hearing is most sensitive around 100–400 Hz in-water, is limited over 1 kHz, and is much less sensitive than that of any marine mammal. The guidelines do not advise on sea snakes, however hearing is most sensitive at low frequencies in these species, as discussed in Section 3.8.2.1.4 (Hearing and Vocalization). For this analysis, it is assumed that hearing loss in sea snakes would be similar to sea turtles.

3.8.3.2.1.3 Physiological Stress

A stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. If the magnitude and duration of the stress response is too great or too long, it can have negative consequences to the animal (e.g. decreased immune function, decreased reproduction). Physiological stress is typically analyzed by measuring stress hormones, other biochemical markers, or vital signs. Physiological stress has been measured for sea turtles during nesting (Flower et al., 2015; Valverde et al., 1999) and capture and handling (Flower et al., 2015; Gregory & Schmid, 2001), but the stress caused by acoustic exposure has not been studied for reptiles. Therefore, the stress response in reptiles in the Study Area due to acoustic exposures is considered to be consistent with general knowledge about physiological stress responses described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

Marine animals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with members of the same species, nesting, and interactions with predators all contribute to stress. Anthropogenic sound-producing activities have the potential to provide additional stressors beyond those that naturally occur.

Due to the limited information about acoustically induced stress responses in reptiles, the Navy conservatively 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.

3.8.3.2.1.4 Masking

As described in Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), auditory masking occurs when one sound, distinguished as the ‘noise,’ interferes with the detection or recognition of another sound or limits the distance over which other biologically relevant sounds can be detected. Masking only occurs when the sound source is operating; therefore, direct masking effects stop immediately upon cessation of the sound-producing activity. Any unwanted sound above ambient noise and within an animal’s hearing range may potentially cause masking which can interfere with an animal’s ability to detect, understand, or recognize biologically relevant sounds of interest.

Masking occurs in all vertebrate groups and can effectively limit the distance over which an animal can communicate and detect biologically relevant sounds. The effect of masking has not been studied for marine reptiles. The potential for masking in reptiles would be limited to certain sound exposures due to their limited hearing range to broadband low-frequency sounds and lower sensitivity to noise in the marine environment. Only continuous human-generated sounds that have a significant low-frequency component, are not of brief duration, and are of sufficient received level could create a meaningful masking situation. While explosions produce intense, broadband sounds with significant low-frequency content, these sounds are very brief with limited potential to mask relevant sounds.

There is evidence that reptiles may rely primarily on senses other than hearing for interacting with their environment, such as vision (Narazaki et al., 2013), magnetic orientation (Avens, 2003; Putman et al., 2015), and scent (Shine et al., 2004). Any effect of masking may be mediated by reliance on other environmental inputs.

3.8.3.2.1.5 Behavioral Reactions

There are no observations of behavioral reactions by aquatic reptiles to exposure to explosive sounds and energy. 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. Although explosive sources are more energetic than air guns, the few studies of sea turtle responses to air guns may show the types of behavioral responses that sea turtles may have towards explosions. General research findings regarding behavioral reactions from sea turtles due to exposure to impulsive sounds, such as those associated with explosions, are discussed in detail in Behavioral Reactions to Impulsive Sound Sources under Section 3.8.3.1 (Acoustic Stressors). This analysis assumes that these guidelines would also apply to sea snakes.

3.8.3.2.1.6 Long-Term Consequences

For reptiles present in the Study Area, long-term consequences to individuals and populations due to acoustic exposures have not been studied. Therefore, long-term consequences to reptiles due to explosive exposures are considered following Section 3.0.3.6.1 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities).

Long-term consequences to a population are determined by examining changes in the population growth rate. 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, which could impact navigation. The long-term consequences due to individual behavioral reactions and short-term (seconds to minutes) instances of physiological stress are especially difficult to predict because individual experience over time can create complex contingencies. 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 exposures to multiple stressors over significant periods of time. Conversely, some reptiles may habituate to or become tolerant of repeated acoustic exposures over time, learning to ignore a stimulus that in the past did not accompany any overt threat. For example, loggerhead sea turtles exposed to air guns with a source SPL of 179 dB re 1 µPa initially exhibited avoidance reactions. However, they may have habituated to the sound source after multiple exposures since a habituation behavior was retained when exposures were separated by several days (Moein Bartol et al., 1995). More research is needed to better understand the long-term consequences of human-made noise on reptiles, although intermittent exposures are assumed to be less likely to have lasting consequences.

3.8.3.2.2 Impacts from Explosives

This section analyzes the impacts on reptiles due to in-water explosions that result from Navy training and testing activities, synthesizing the background information presented above.

3.8.3.2.2.1 Methods for Analyzing Impacts from Explosives

Potential impacts considered are mortality, injury, hearing loss due to threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, and changes in behavior. The Navy's quantitative analysis to determine impacts on sea turtles and marine mammals uses the Navy Acoustic Effects Model to produce initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. 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 and spatial distribution of sea turtles; 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.

The technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* provides a further detailed explanation of this analysis (U.S. Department of the Navy, 2017c).

Since sea snakes have similar hearing range and sensitivity as sea turtles, as described in Section 3.8.2.1.4 (Hearing and Vocalization), it is inferred that sea snakes could react similarly to explosions as sea turtles.

Criteria and Thresholds used to Predict Impacts on Sea Turtles from Explosives

Mortality and Injury from Explosives

As discussed above in Section 3.8.3.2.1.1 (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).

Two sets of thresholds 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 3.8-5). The thresholds for the farthest range to effect are based on the received level at which 1 percent risk is predicted and are useful for assessing mitigation effectiveness. 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, sea turtle populations are assumed to be 5 percent adult and 95 percent sub-adult. This adult to sub-adult population ratio is estimated from what is known about the population age structure for sea turtles. Sea turtles typically lay multiple clutches of 100 or more eggs with little parental investment and generally have low survival in early life. However, sea turtles that are able to survive past early life generally have high age-specific survival in later life.

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, 2017a).

Table 3.8-5: 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	$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Injury[1]	$65.8\mathrm{M}^{1/3}\left(1+\frac{\mathrm{D}}{10.1}\right)^{1/6}$ Pa-s	$47.5\mathrm{M}^{1/3}\left(1+\frac{\mathrm{D}}{10.1}\right)^{1/6}$ Pa-s
	243 dB re 1 µPa SPL peak	237 dB re 1 µPa SPL peak

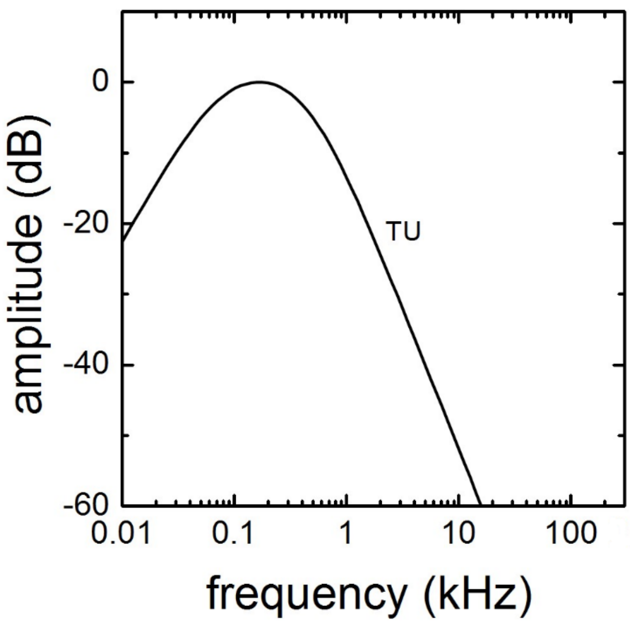
[1] Impulse delivered over 20% of the estimated lung resonance period. See U.S. Department of the Navy (2017a).
[2] Threshold for 1% risk used to assess mitigation effectiveness.
Note: dB re 1 µPa = decibels referenced to 1 micropascal, SPL = sound pressure level

When explosive munitions (e.g., a bomb or missile) detonates, fragments of the weapon are thrown at high-velocity from the detonation point, which can injure or kill sea turtles 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 & Montaro, 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. 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. The adjusted received sound level is referred to as a weighted received sound level.

The auditory weighting function for sea turtles is shown in Figure 3.8-7. The derivation of this weighting function is described in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017a). The frequencies around the top portion of the function, where the amplitude is closest to zero, are emphasized, while the frequencies below and above this range (where amplitude declines) are de-emphasized, when summing acoustic energy received by a sea turtle.



Source: (U.S. Department of the Navy, 2017a).

Figure 3.8-7: Auditory Weighting Functions for Sea Turtles

Notes: dB = decibels, kHz = kilohertz, TU = sea turtle hearing group

Hearing Loss from Explosives

No studies of hearing loss have been conducted on sea turtles. Therefore, sea turtle susceptibility to hearing loss due to an acoustic exposure is evaluated using knowledge about sea turtle hearing abilities in combination with non-impulsive auditory effect data from other species (marine mammals and fish). This yields sea turtle exposure functions, shown in Figure 3.8-8, which are mathematical functions that relate the SELs for onset of TTS or PTS to the frequency of the sonar sound exposure. The derivation of the sea turtle exposure functions 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, 2017a).

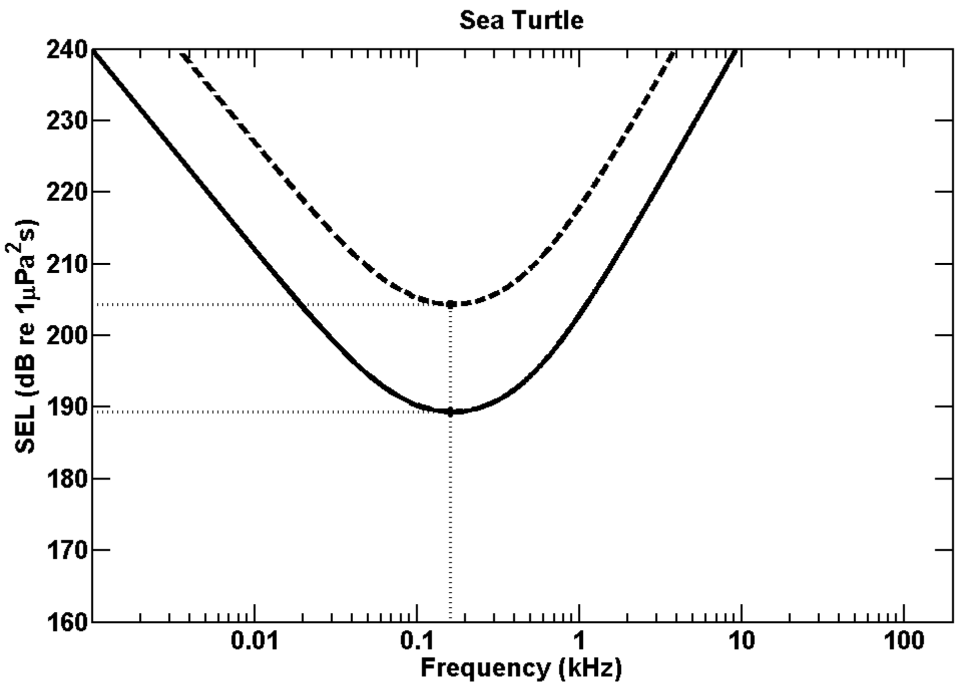


Figure 3.8-8: TTS and PTS Exposure Functions for Impulsive Sounds

Notes: kHz = kilohertz, SEL = Sound Exposure Level, dB re 1 μPa²s = decibels referenced to 1 micropascal squared second. The solid black curve is the exposure function for TTS onset and the dashed black curve is the exposure function for PTS onset. Small dashed lines and asterisks indicate the SEL thresholds and most sensitive frequency for TTS and PTS.

For impulsive sounds, hearing loss in other species has also been observed to be related to the unweighted peak pressure of a received sound. Because this data does not exist for sea turtles, unweighted peak pressure thresholds for TTS and PTS were developed by applying relationships observed between impulsive peak pressure TTS thresholds and auditory sensitivity in marine mammals to sea turtles. This results in dual-metric hearing loss criteria for sea turtles for impulsive sound exposure: the SEL-based exposure functions in Figure 3.8-8 and the peak pressure thresholds in Table 3.8-6. The derivation of the sea turtle impulsive peak pressure TTS and PTS thresholds 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, 2017a).

Table 3.8-6: TTS and PTS Peak Pressure Thresholds Derived for Sea Turtles Exposed to Impulsive Sounds

Auditory Effect	*Unweighted Peak Pressure Threshold*
TTS	226 dB re 1 µPa SPL peak
PTS	232 dB re 1 µPa SPL peak

Notes: dB re 1 µPa = decibels referenced to 1 micropascal, PTS = permanent threshold shift, SPL = sound pressure level, TTS = temporary threshold shift

Accounting for Mitigation

The Navy will implement mitigation measures to avoid or reduce potential impacts from explosives on sea turtles, 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 sea turtle is observed in a mitigation zone. The mitigation zones for explosives extend beyond the respective average ranges to mortality. Therefore, the impact analysis quantifies the potential for 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., 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, 2017c).

In the quantitative analysis, consideration of mitigation measures means that, for activities where mitigation is feasible, model-estimated mortality is considered mitigated to the level of injury. The impact analysis does not analyze 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.

3.8.3.2.2.2 Impact Ranges for Explosives

Ranges to effect (Table 3.8-7 through 3.8-10) were developed in the Navy Acoustic Effects Model based on the thresholds for TTS, PTS, injury, and mortality discussed above.

Table 3.8-7: Ranges to Mortality for Sea Turtles Exposed to Explosives as a Function of Animal Mass[1]

Bin	*Animal Mass Intervals (kg)*[1,2]	
	10	*150*
E1	4 (3–4)	0 (0–2)
E2	5 (5–6)	2 (2–2)
E3	11 (9–12)	4 (4–5)
E4	20 (0–45)	9 (0–16)
E5	17 (14–55)	8 (7–24)
E6	23 (19–70)	11 (9–30)
E7	89 (75–200)	36 (30–60)
E8	69 (30–140)	28 (16–35)
E9	45 (40–140)	22 (22–23)
E10	96 (50–240)	25 (25–25)
E11	277 (250–600)	122 (120–190)
E12	131 (65–400)	36 (30–80)

[1] Ranges based on the mortality impact threshold (see Criteria and Thresholds Used to Predict Impacts from Explosives) in Section 3.8.3.2.2.1 (Methods for Analyzing Impacts from Explosives).

[2] Average distance (m) to mortality is depicted above the minimum and maximum distances which are in parentheses.

Note: Bin E13 is not modeled because it consists of multiple mat weave charges, where the majority of the energy is transferred into the air and to the bottom as a bottom-laid distributed charge in very shallow water.

Table 3.8-8: Ranges to Non-Auditory Injury[1] (in meters) for Sea Turtles Exposed to Explosives as a Function of Animal Mass

Bin	*Animal Mass Intervals (kg)*[1]	
	10	*150*
E1	22 (21–24)	22 (21–24)
E2	26 (25–30)	26 (25–30)
E3	46 (35–65)	46 (35–65)
E4	62 (0–130)	62 (0–130)
E5	77 (45–170)	77 (45–130)
E6	98 (50–230)	98 (50–230)
E7	190 (140–550)	173 (140–460)
E8	173 (160–430)	173 (160–430)
E9	225 (220–380)	225 (220–230)
E10	278 (140–600)	278 (140–310)
E11	544 (460–2,025)	399 (320–1,025)
E12	354 (320–1,025)	354 (320–400)

[1] Ranges based on the injury impact threshold (see Criteria and Thresholds used to Predict Impacts from Explosives in Section 3.8.3.2.2.1. Methods for Analyzing Impacts from Explosives).

[2] Average distance (m) to non-auditory injury is depicted above the minimum and maximum distances, which are in parentheses. The ranges depicted are the further of the ranges for gastrointestinal tract injury or slight lung injury for an explosive bin and animal mass interval combination.

Note: Bin E13 is not modeled because it consists of multiple mat weave charges, where the majority of the energy is transferred into the air and to the bottom as a bottom-laid distributed charge in very shallow water.

Table 3.8-9: Peak Pressure Based Ranges to TTS and PTS for Sea Turtles Exposed to Explosives

Range to Effects for Explosives Bin: Sea Turtles[1]			
Bin	Source Depth (m)	PTS	TTS
E1	0.1	35 (30–40)	66 (40–95)
E2	0.1	46 (35–50)	85 (45–95)
E3	0.1	79 (45–95)	140 (60–150)
	18.25	80 (80–100)	158 (150–480)
E4	3	175 (130–210)	375 (220–410)
	15.25	114 (100–190)	252 (190–420)
	19.8	100 (100–100)	190 (190–190)
	198	75 (75–75)	170 (170–170)
E5	0.1	122 (55–130)	223 (80–250)
	15.25	144 (130–310)	278 (240–725)
E6	0.1	154 (65–170)	278 (95–320)
	3	215 (190–260)	463 (330–625)
	15.25	197 (170–410)	396 (310–825)
E7	3	355 (260–500)	614 (490–750)
	18.25	376 (260–550)	587 (470–675)
E8	0.1	276 (260–300)	476 (370–575)
	45.75	348 (280–950)	658 (500–1,775)
E9	0.1	370 (320–420)	620 (420–825)
E10	0.1	439 (230–550)	725 (330–1,025)
E11	18.5	765 (625–1,000)	1,342 (950–2,025)
	45.75	657 (525–1,775)	1,096 (825–3,025)

Table 3.8-9: Peak Pressure Based Ranges to TTS and PTS for Sea Turtles Exposed to Explosives (continued)

Range to Effects for Explosives Bin: Sea Turtles[1]			
Bin	Source Depth (m)	PTS	TTS
E12	0.1	548 (400–700)	925 (500–1,275)

[1]Average distance (m) to TTS and PTS are depicted above the minimum and maximum distances, which are in parentheses. Values depict ranges to TTS and PTS based on the peak pressure metric.
Note: Bin E13 is not modeled because it consists of multiple mat weave charges, where the majority of the energy is transferred into the air and to the bottom as a bottom-laid distributed charge in very shallow water.

Table 3.8-10: SEL Based Ranges to TTS and PTS for Sea Turtles Exposed to Explosives

Range to Effects for Explosives Bin: Sea Turtles[1]				
Bin	Source Depth (m)	Cluster Size	PTS	TTS
E1	0.1	1	0 (0–0)	0 (0–0)
		25	0 (0–0)	2 (2–5)
E2	0.1	1	0 (0–0)	0 (0–2)
		10	0 (0–0)	3 (2–3)
E3	0.1	1	0 (0–0)	3 (2–3)
		12	1 (0–2)	8 (8–25)
	18.25	1	3 (3–3)	17 (16–18)
		12	1 (0–2)	8 (8–25)
E4	3	2	17 (11–18)	57 (50–70)
	15.25	2	8 (7–9)	63 (55–70)
	19.8	2	7 (7–7)	50 (50–50)
	198	2	0 (0–0)	0 (0–0)
E5	0.1	25	6 (6–25)	45 (25–280)
	15.25	25	59 (55–75)	349 (240–950)

Table 3.8-10: SEL Based Ranges to TTS and PTS for Sea Turtles Exposed to Explosives (continued)

Range to Effects for Explosives Bin: Sea Turtles[1]				
Bin	Source Depth (m)	Cluster Size	PTS	TTS
E6	0.1	1	2 (2–2)	10 (10–45)
	3	1	30 (30–30)	143 (140–150)
	15.25	1	17 (15–25)	133 (100–360)
E7	3	1	55 (55–55)	273 (230–360)
	18.25	1	52 (45–90)	526 (330–750)
E8	0.1	1	5 (5–8)	44 (25–280)
	45.75	1	40 (40–50)	289 (260–975)
E9	0.1	1	9 (9–35)	91 (40–525)
E10	0.1	1	13 (13–90)	189 (50–850)
E11	18.5	1	314 (240–525)	2,105 (1,525–2,525)
	45.75	1	171 (170–200)	879 (700–2,275)
E12	0.1	1	32 (18–170)	273 (80–1,275)

[1]Average distance (m) to TTS and PTS are depicted above the minimum and maximum distances, which are in parentheses. Values depict ranges to TTS and PTS based on the SEL metric.
Note: Bin E13 is not modeled because it consists of multiple mat weave charges, where the majority of the energy is transferred into the air and to the bottom as a bottom-laid distributed charge in very shallow water.

3.8.3.2.2.3 Presentation of Estimated Impacts from the Quantitative Analysis

The results of the analysis of potential impacts on sea turtles from explosives as described in Section 3.8.3.2.2.1 (Methods for Analyzing Impacts from Explosives) are discussed below. Estimated numbers of potential impacts from the quantitative analysis for each species of sea turtle from exposure to explosive energy and sound for training and testing activities are presented below. The most likely regions and activity categories from which the impacts could occur are displayed in the figures for each species of sea turtle. There is a potential for impacts could occur anywhere within the Study Area where sound and energy from explosions and the species overlap, although only areas or categories where 0.5 percent of the impact, or greater, are estimated to occur are graphically represented on the species-specific figures below. All (i.e., grand total) estimated impacts are included in the graphics, regardless of region or category.

The numbers of activities planned can vary slightly from year-to-year. Results are presented for a maximum explosive use year; however, during most years, explosive use would be less, resulting in fewer potential impacts. Section 3.0.3.3.2 (Explosive Stressors) describes the number of explosives used. Impacts on sea turtles are discussed qualitatively below as appropriate.

3.8.3.2.2.4 Impacts from Explosives Under Alternative 1

Impacts from Explosives Under Alternative 1 for Training Activities

Activities using explosives would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics, quantities, and net explosive weights of in-water explosives used during training under Alternative 1 are provided in Section 3.0.3.3.2 (Explosive Stressors). Quantities and locations of fragment-producing explosives during training under Alternative 1 are shown in 3.0.3.3.4.2 (Military Expended Materials). Under Alternative 1, the number of explosions that could occur annually could fluctuate, although potential impacts would be similar from year to year.

Training activities involving explosions would typically be conducted in the range complexes, with little explosive activity in the Transit Corridor. Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore.

The estimated impacts on sea turtles from explosions during a maximum year of training under Alternative 1 are presented in Figure 3.8-9 (for impact tables, see Appendix F, Military Expended Material and Direct Strike Impact Analyses). Under Alternative 1, it is possible that impacts would be slightly reduced in some years, as explosive use would fluctuate. Sea turtle density estimates in the Southern California portion of the Study Area are limited to green sea turtles in San Diego Bay and do not exist in offshore areas where leatherback and loggerhead sea turtles could co-occur with explosions. Therefore, exposures were only modeled for green sea turtles in the San Diego Bay portion of the Southern California Range Complex and for green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles in the Hawaii Range Complex and Transit Corridor. Explosives would not be used in the San Diego Bay during training activities; thus, the population in the bay would not be affected. However, green sea turtles could occur outside of the bay during migrations.

The quantitative analysis, using a maximum year of training activities, estimates that no sea turtles would be killed; however, a small number of green sea turtles would be exposed to levels of explosive sound and energy that could cause TTS, PTS, or injury (Figure 3.8-9). The quantitative analysis predicts that no hawksbill, leatherback, loggerhead, or olive ridley sea turtles are likely to be exposed to the levels of explosive sound and energy that could cause TTS, PTS, or injury during training activities under Alternative 1. Fractional estimated impacts per region and activity area represent the probability that the number of estimated impacts by effect will occur in a certain region or be due to a certain activity category.

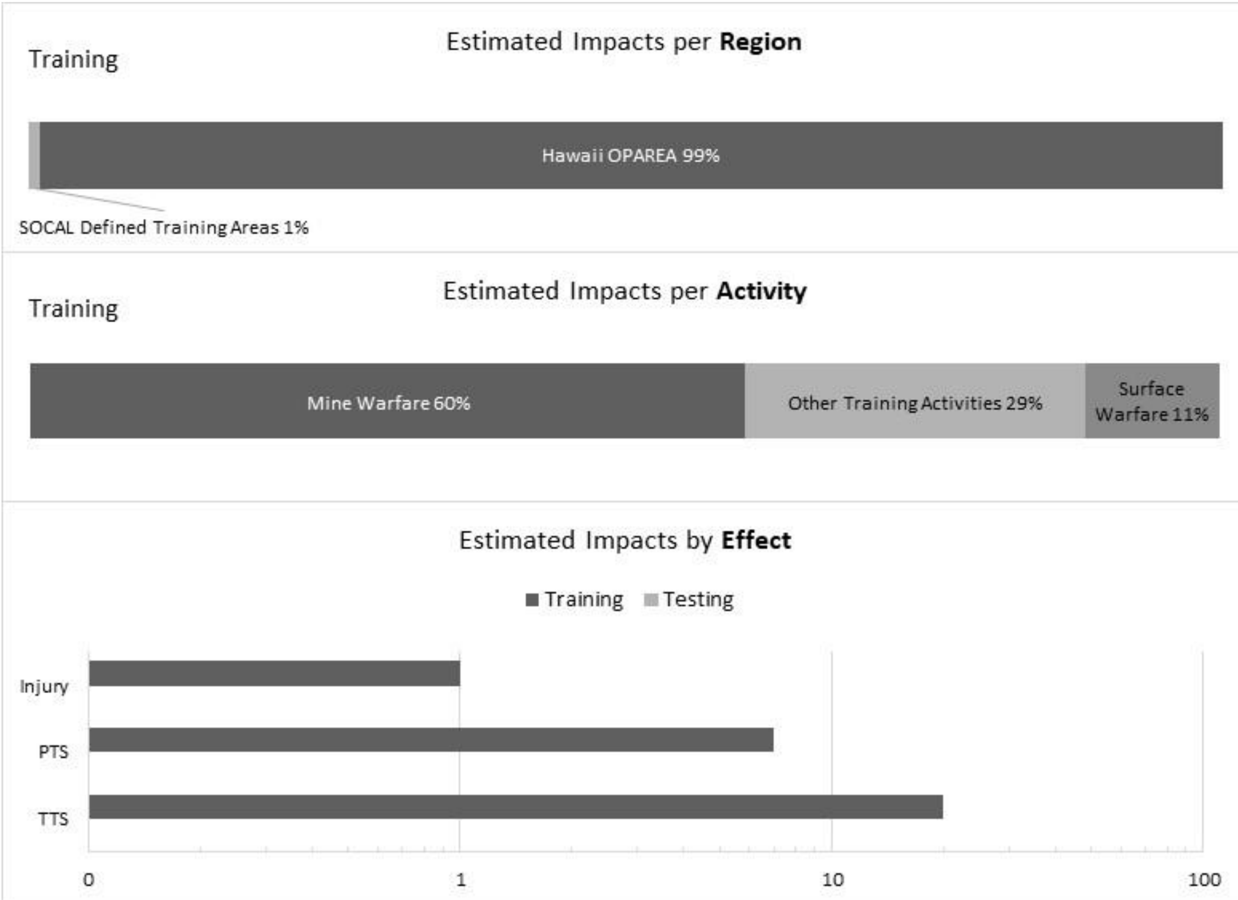


Figure 3.8-9: Green Sea Turtle Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 1

Note: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for testing activities.
ASW = Anti-Submarine Warfare

Threshold shifts and injuries could reduce the fitness of an individual animal, causing a reduction in foraging success, reproduction, or increased susceptibility to predators. This reduction in fitness would be temporary for recoverable impacts, such as TTS, but there could be long-term consequences to some individuals. However, no population-level impact is expected due to the low number of estimated injuries for any sea turtle species relative to total population size.

As discussed in Section 5.3.3 (Explosive Stressors), procedural mitigation includes ceasing explosive detonations (e.g., ceasing deployment of an explosive bomb, ceasing explosive missile firing) if a sea turtle is observed in the mitigation zone, whenever and wherever applicable activities occur. In addition to this procedural mitigation, the Navy will implement mitigation to avoid impacts from explosions on seafloor resources in mitigation areas throughout the Study Area, as described in Section 5.4.1 (Mitigation Areas for Seafloor Resources). This will further reduce the potential for impacts on sea turtles that shelter and feed on shallow-water coral reefs, precious coral beds, live hard bottom, artificial reefs, and shipwrecks.

Reptile hearing is less sensitive than other marine animals (i.e., marine mammals), and the role of their underwater hearing is unclear. Reptiles' limited hearing range (<2 kHz) is most likely used to detect nearby broadband, continuous environmental sounds, such as the sounds of waves crashing on the beach, that may be important for identifying their habitat. Recovery from a hearing threshold shift begins almost immediately after the noise exposure ceases. A temporary threshold shift is expected to take a few minutes to a few days, depending on the severity of the initial shift, to fully recover (U.S. Department of the Navy, 2017a). If any hearing loss remains after recovery, that remaining hearing threshold shift is permanent. Because explosions produce broadband sounds with low-frequency content, hearing loss due to explosive sound could occur across a sea turtle's very limited hearing range, reducing the distance over which relevant sounds, such as beach sounds, may be detected for the duration of the threshold shift.

Some reptiles may behaviorally respond to the sound of an explosive. A reptile's behavioral response to a single detonation or explosive cluster is expected to be limited to a short-term (seconds to minutes) startle response, as the duration of noise from these events is very brief. Limited research and observations from air gun studies (see Section 3.8.3.2.2.1, Methods for Analyzing Impacts from Explosives) suggest that if sea turtles are exposed to repetitive impulsive sounds in close proximity, they may react by increasing swim speed, avoiding the source, or changing their position in the water column. There is no evidence to suggest that any behavioral response would persist beyond the sound exposure. Because the duration of most explosive events is brief, the potential for masking is low. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) consider masking to not be a concern for sea turtles exposed to explosions. This can also be assumed for sea snakes.

A physiological stress response is assumed to accompany any injury, hearing loss, or behavioral reaction. A stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. While the stress response is a normal function for an animal dealing with natural stressors in their environment, chronic stress responses could reduce an individual's fitness. Due to the low number of estimated impacts, it is not likely that any reptile would experience repeated stress responses due to explosive impacts.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), and the low number of estimated impacts for green sea turtles and no estimated impacts for hawksbill, leatherback, loggerhead, or olive ridley sea turtles during explosives training, long-term consequences for the population would not be expected. It is reasonable to assume that sea snakes use their hearing similarly to sea turtles and that any impacts on sea snakes would be similar to the types of impacts described for sea turtles.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with explosives from training activities.

Pursuant to the ESA, use of explosives during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect the ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles. 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

Activities using explosives would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics, quantities, and net explosive weights of in-water explosives used during testing under Alternative 1 are provided in

Section 3.0.3.3.2 (Explosive Stressors). Quantities and locations of fragment-producing explosives during testing under Alternative 1 are shown in 3.0.3.3.4.2 (Military Expended Materials). Testing activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore and in the range complexes, rather than in the Transit Corridor.

Under Alternative 1, the number of testing activities using explosives could fluctuate annually. The quantitative analysis predicts that no sea turtles of any species are likely to be killed, injured, or be exposed to sound that would cause TTS or PTS due to explosives during a maximum year of testing activities under Alternative 1.

As discussed in Section 5.3.3 (Explosive Stressors), procedural mitigation includes ceasing explosive detonations (e.g., ceasing deployment of an explosive bomb) if a sea turtle is observed in the mitigation zone, whenever and wherever applicable activities occur. In addition to this procedural mitigation, the Navy will implement mitigation to avoid impacts from explosives on seafloor resources in mitigation areas throughout the Study Area, as described in Section 5.4.1 (Mitigation Areas for Seafloor Resources). This will further reduce the potential for impacts on sea turtles that shelter and feed on shallow-water coral reefs, precious coral beds, live hard bottom, artificial reefs, and shipwrecks

Some reptiles may behaviorally respond to the sound of an explosive. A sea turtle response to a single detonation or explosive cluster is expected to be limited to a short-term startle response, as the duration of noise from these events is very brief. Limited research and observations from air gun studies (see Section 3.8.3.2.2.1, Methods for Analyzing Impacts from Explosives) suggest that if sea turtles are exposed to repetitive impulsive sounds in close proximity, they may react by increasing swim speed, avoiding the source, or changing their position in the water column. There is no evidence to suggest that any behavioral response would persist beyond the sound exposure. Because the duration of most explosive events is brief, the potential for masking is low. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) consider masking to not be a concern for sea turtles exposed to explosions.

A physiological stress response is assumed to accompany any injury, hearing loss, or behavioral reaction. A stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. While the stress response is a normal function for an animal dealing with natural stressors in their environment, chronic stress responses could reduce an individual's fitness. Because the duration of most explosive events is brief, the potential for masking is low. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) consider masking to not be a concern for sea turtles exposed to explosions.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), and no estimated impacts for green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles during explosives testing, long-term consequences for the population would not be expected. It is reasonable to assume that sea snakes use their hearing similarly to sea turtles and that any impacts on sea snakes would be similar to the types of impacts described for sea turtles.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with explosives from testing activities.

Pursuant to the ESA, use of explosives during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.2.2.5 Impacts from Explosives Under Alternative 2

Impacts from Explosives Under Alternative 2 for Training Activities

Under Alternative 2, the maximum number of training activities using explosives could occur every year. Activities using explosives would be conducted as described in Chapter 2 (Description of Proposed Action and Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics, quantities, and net explosive weights of in-water explosives used during training under Alternative 2 are provided in Section 3.0.3.3.2 (Explosive Stressors). Quantities and locations of fragment-producing explosives during training under Alternative 2 are shown in 3.0.3.3.4.2 (Military Expended Materials).

Training activities involving explosions would typically be conducted in the range complexes, with little explosive activity in the Transit Corridor. Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore.

The estimated impacts on sea turtles from explosions during a maximum year of training under Alternative 2 are presented in Figure 3.8-10. Estimated impacts for Alternative 2 are identical to those described in Section 3.8.3.2.2.4 (Impacts from Explosives Under Alternative 1). Sea turtle density estimates in the Southern California portion of the Study Area are limited to green sea turtles in San Diego Bay and do not exist in offshore areas where leatherback and loggerhead sea turtles could co-occur with explosions. Therefore, exposures were only modeled for green sea turtles in the San Diego Bay portion of the Southern California Range Complex and for green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles in the Hawaii Range Complex and Transit Corridor. Explosives would not be used in the San Diego Bay during training activities; thus, the population in the bay would not be affected. However, green sea turtles could occur outside of the bay during migrations.

The quantitative analysis estimates that no sea turtles would be killed, however, a small number of green sea turtles would be exposed to levels of explosive sound and energy that could cause TTS, PTS, and injury (Figure 3.8-10). The quantitative analysis predicts that no hawksbill, leatherback, loggerhead, or olive ridley sea turtles are likely to be exposed to the levels of explosive sound and energy that could cause TTS, PTS, or injury during training activities under Alternative 2. Fractional estimated impacts per region and activity area represent the probability that the number of estimated impacts by effect will occur in a certain region or be due to a certain activity category.

Threshold shifts and injuries could reduce the fitness of an individual animal, causing a reduction in foraging success, reproduction, or increased susceptibility to predators. This reduction in fitness would be temporary for recoverable impacts, such as TTS, but there could be long-term consequences to some individuals. However, no population-level impact is expected due to the low number of estimated injuries for any sea turtle species relative to total population size.

As discussed in Section 5.3.3 (Explosives Stressors), procedural mitigation includes ceasing explosive detonations (e.g., ceasing deployment of an explosive bomb) if a sea turtle is observed in the mitigation zone, whenever and wherever applicable activities occur. In addition to this procedural mitigation, the Navy will implement mitigation to avoid impacts from explosives on seafloor resources in mitigation areas throughout the Study Area, as described in Section 5.4.1 (Mitigation Areas for Seafloor Resources). This will further reduce the potential for impacts on sea turtles that shelter and feed on shallow-water coral reefs, precious coral beds, live hard bottom, shipwrecks, and artificial reefs.

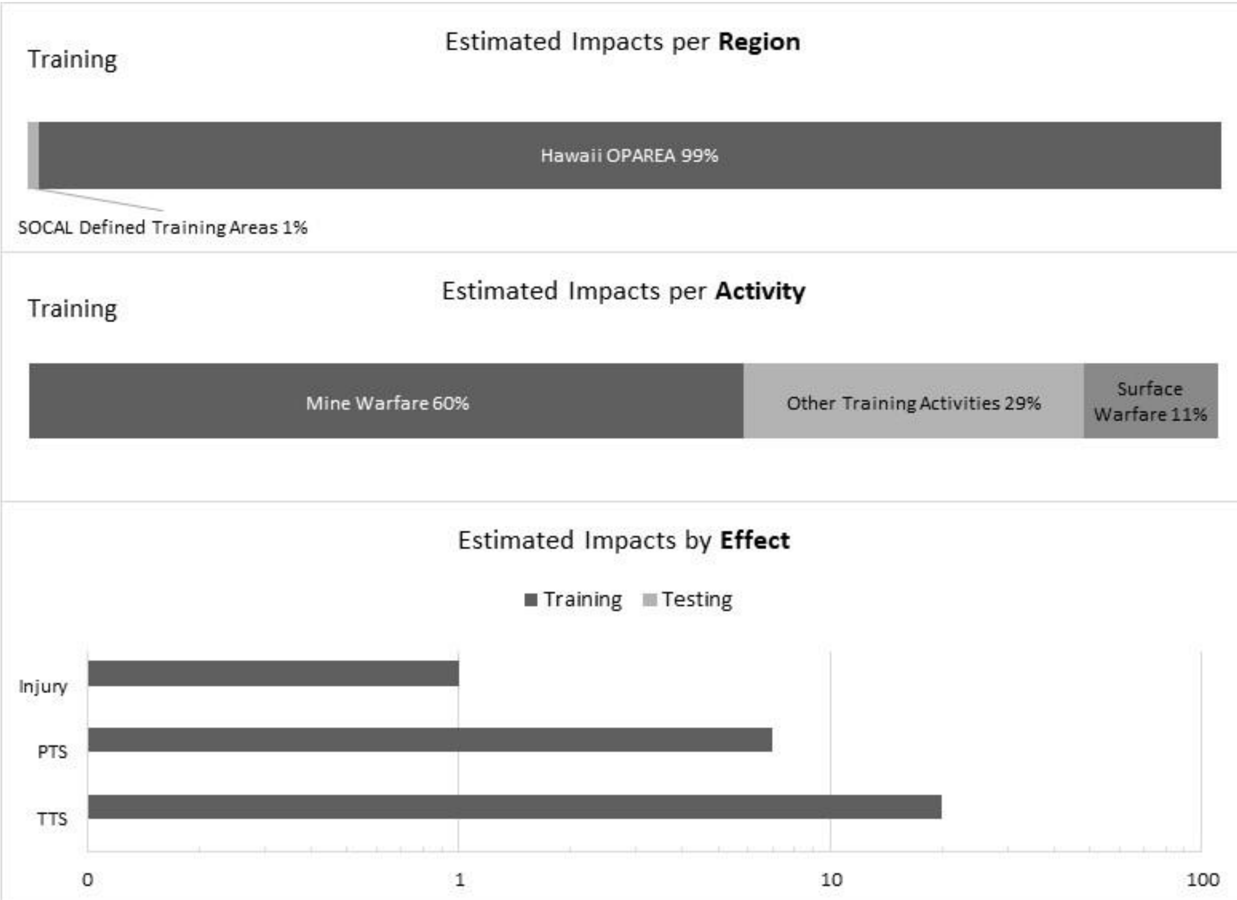


Figure 3.8-10: Green Sea Turtle Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under Alternative 2.

Notes: Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for testing activities.
ASW = Anti-Submarine Warfare

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), and the low number of estimated impacts for green sea turtles and no estimated impacts for hawksbill, leatherback, loggerhead, or olive ridley sea turtles during explosives training, long-term consequences for the population would not be expected. It is reasonable to assume that sea snakes use their hearing similarly to sea turtles and that any impacts on sea snakes would be similar to the types of impacts described for sea turtles.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with explosives from training activities.

Pursuant to the ESA, use of explosives during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

Impacts from Explosives Under Alternative 2 for Testing Activities

Under Alternative 2, the maximum number of testing activities could occur every year. Activities using explosives would be conducted as described in Chapter 2 (Description of Proposed Action and

Alternatives) and Appendix A (Navy Activity Descriptions). General characteristics, quantities, and net explosive weights of in-water explosives used during testing under Alternative 2 are provided in Section 3.0.3.3.2 (Explosive Stressors). Quantities and locations of fragment-producing explosives during testing under Alternative 2 are shown in 3.0.3.3.4.2 (Military Expended Materials). Testing activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore and in the range complexes, rather than in the Transit Corridor.

Activities that involve underwater detonations and explosive munitions typically occur more than 3 NM from shore and in the range complexes rather than in the Transit Corridor.

The impacts due to the use of explosives during a maximum year of testing under Alternative 2 are identical to Alternative 1, as described above in Section 3.8.3.2.2.4 (Impacts from Explosives Under Alternative 1 for Testing Activities). The quantitative analysis predicts that no sea turtles of any species are likely to be killed, injured, or be exposed to sound that would cause TTS or PTS due to explosives during a maximum year of testing activities under Alternative 2. As discussed in Section 5.3.3 (Explosive Stressors), procedural mitigation includes ceasing explosive detonations (e.g., ceasing deployment of an explosive bomb) if a sea turtle is observed in the mitigation zone whenever and wherever applicable activities occur. In addition to this procedural mitigation, the Navy will implement mitigation to avoid impacts from explosives on seafloor resources in mitigation areas throughout the Study Area, as described in Section 5.4.1 (Mitigation Areas for Seafloor Resources). This will further reduce the potential for impacts on sea turtles that shelter and feed on shallow-water coral reefs, precious coral beds, live hard bottom, artificial reefs, and shipwrecks.

Considering the above factors and the mitigation measures that would be implemented as described in Chapter 5 (Mitigation), and no estimated impacts for green, hawksbill, leatherback, loggerhead, or olive ridley sea turtles during explosives testing, long-term consequences for the population would not be expected. It is reasonable to assume that sea snakes, use their hearing similarly to sea turtles and that any impacts on sea snakes would be similar to the types of impacts described for sea turtles.

Leatherback sea turtle critical habitat occurs north of the Study Area, as described in Section 3.8.2.2.5.1 (Status and Management), and would not overlap with explosives from testing activities.

Pursuant to the ESA, use of explosives during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat, but may affect ESA-listed green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles.

3.8.3.2.2.6 Impacts from Explosives Under the No Action Alternative

Under the No-Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various explosive stressors (e.g., explosions in-air, explosions in-water) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.3 Energy Stressors

This section analyzes the potential impacts of energy stressors used during training and testing activities within the Study Area. This section includes analysis of the potential impacts of: (1) in-water electromagnetic devices and (2) high-energy lasers. General discussion of impacts can also be found in Section 3.0.3.6.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities).

3.8.3.3.1 Impacts from In-Water Electromagnetic Devices

For a discussion of the types of activities that create an electromagnetic field underwater, refer to Appendix B (Activity Stressor Matrices), and for information on locations and the number of activates proposed for each alternative, see Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices). The devices producing an electromagnetic field are towed or unmanned mine countermeasure systems. The electromagnetic field is produced to simulate a vessel's magnetic field. In an actual mine-clearing operation, the intent is that the electromagnetic field would trigger an enemy mine designed to sense a vessel's magnetic field.

Although the yellow-bellied sea snake can swim long distances in the open ocean, this species seems to rely on currents and temperature cues for orientation rather than electromagnetic fields. There has been some literature that discusses potential adverse impacts of electromagnetic radiation on breeding activity of various species (Gill et al., 2014; Hartwell et al., 1991; Hore, 2012; Larkin & Sutherland, 1977; Thomsen et al., 2015); however, no yellow-bellied snake breeding activity occurs in the Study Area. Because yellow-bellied sea snake reproduction and orientation would not be affected by electromagnetic devices, the analysis for electromagnetic devices and the impacts that may potentially occur from their use is limited to sea turtles.

Well over a century ago, electromagnetic fields were introduced into the marine environment within the Study Area from a wide variety of sources (e.g., power transmission cables), yet little is known about the potential impacts on marine life. There is consensus, however, that magnetic fields and other cues (e.g., visual cues), are important for sea turtle orientation and navigation (Lohmann et al., 1997; Putman et al., 2015). Studies on behavioral responses to magnetic fields have been conducted on green and loggerhead sea turtles. Loggerheads were found to be sensitive to field intensities ranging from 0.005 to 4,000 microteslas, and green sea turtles were found to be sensitive to field intensities from 29.3 to 200 microteslas (Normandeau et al., 2011). Because these data are the best available information, this analysis assumes that the responses would be similar for other sea turtle species. Sea turtles use geomagnetic fields to navigate at sea, and therefore changes in those fields could impact their movement patterns (Lohmann & Lohmann, 1996; Lohmann et al., 1997). Turtles in all life stages orient to the earth's magnetic field to position themselves in oceanic currents; this helps them locate seasonal feeding and breeding grounds and to return to their nesting sites (Lohmann & Lohmann, 1996; Lohmann et al., 1997). Experiments show that sea turtles can detect changes in magnetic fields, which may cause them to deviate from their original direction (Lohmann & Lohmann, 1996; Lohmann et al., 1997). For example, Teuten et al. (2007) found that loggerhead hatchlings tested in a magnetic field of 52 microteslas swam eastward, and when the field was decreased to 43 microteslas, the hatchlings swam westward. Sea turtles also use nonmagnetic cues for navigation and migration, and these additional cues may compensate for variations in magnetic fields. Putman et al. (2015) conducted experiments on loggerhead hatchlings and determined that electromagnetic fields may be more important for sea turtle navigation in areas that may constrain a turtle's ability to navigate (cold temperatures or displacement from a migration route). The findings of this study suggest that the magnetic orientation behavior of sea turtles is closely associated with ocean ecology and geomagnetic environment (Putman et al., 2015).

Liboff (2015) determined that freshly hatched sea turtles are able to detect and use the local geomagnetic field as a reference point before embarking a post-hatchling migration. Liboff proposed that the information is transferred from the mother to the egg through some undetermined geomagnetic imprinting process (Liboff, 2015). Aspects of electromagnetic stressors that are applicable to marine organisms in general are described in Section 3.0.3.6.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities).

As stated in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices), the static magnetic fields generated by electromagnetic devices used in training and testing activities are of relatively minute strength. The maximum strength of the magnetic field is approximately 2,300 microteslas, with the strength of the field decreasing further from the device. At a distance of 4 m from the source of a 2,300 microtesla magnetic field, the strength of the field is approximately 50 microteslas, which is within the range of the Earth's magnetic field (25 to 65 microteslas). At 8 m, the strength of the field is approximately 40 percent of the Earth's magnetic field, and only 10 percent at 24 m away from a 2,300 microtesla magnetic field at the source. At a distance of 200 m the magnetic field would be approximately 0.2 microteslas (U.S. Department of the Navy, 2005), which is less than one percent of the strength of the Earth's magnetic field. This is likely within the range of detection for sea turtle species, but at the lower end of their sensitivity range.

3.8.3.3.1.1 Impacts from In-Water Electromagnetic Devices Under Alternative 1

Impacts from In-Water Electromagnetic Devices Under Alternative 1 for Training Activities

As discussed in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices), training activities that use in-water electromagnetic devices would occur within the Hawaii Range Complex and Southern California Range Complex. All sea turtle species in the Study Area could occur in these locations and could be exposed to the electromagnetic fields.

If located in the immediate area (within about 200 m) where electromagnetic devices are being used, adult, sub-adult, and hatchling sea turtles could deviate from their original movements, but the extent of this disturbance is likely to be inconsequential because of the low likelihood of a sea turtle occurring within 200 m of the device and the movement through the area of both the turtle and the device. In addition, potential impacts on sea turtles are not anticipated because any potential effects are likely limited to a few minor disturbances, which would be similar to natural stressors regularly occurring in the animal's life cycle. The electromagnetic devices used in training activities are not expected to cause more than a short-term behavioral disturbance to sea turtles because of the: (1) relatively low intensity of the magnetic fields generated (0.2 microteslas at 200 m from the source), (2) very localized potential impact area, and (3) temporary duration of the activities (hours). Potential impacts of exposure to electromagnetic stressors are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts.

Pursuant to the ESA, the use of in-water electromagnetic devices during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles (because close proximity to an electromagnetic field may cause temporary disorientation or temporarily disrupt migratory direction). The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from In-Water Electromagnetic Devices Under Alternative 1 for Testing Activities

As discussed in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices), offshore testing activities that use in-water electromagnetic devices would occur within the Hawaii Range Complex and the Southern

California Range Complex. All sea turtle species in the Study Area could occur in these locations and could be exposed to the electromagnetic fields.

If located in the immediate area (within about 200 m) where electromagnetic devices are being used, adult, sub-adult, and hatchling sea turtles could deviate from their original movements, but the extent of this disturbance is likely to be inconsequential because of the low likelihood of a sea turtle occurring within 200 m of the device and the movement through the area of both the turtle and the device. In addition, potential impacts on sea turtles are not anticipated because any potential effects are likely limited to a few minor disturbances, which would be similar to natural stressors regularly occurring in the animal's life cycle. The electromagnetic devices used in training activities are not expected to cause more than a short-term behavioral disturbance to sea turtles because of the: (1) relatively low intensity of the magnetic fields generated (0.2 microteslas at 200 m from the source), (2) very localized potential impact area, and (3) temporary duration of the activities (hours). Potential impacts of exposure to electromagnetic stressors are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts.

Pursuant to the ESA, the use of in-water electromagnetic devices during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles (because close proximity to an electromagnetic field may cause temporary disorientation or temporarily disrupt migratory direction). The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.3.1.2 Impacts from In-Water Electromagnetic Devices Under Alternative 2

Impacts from In-Water Electromagnetic Devices Under Alternative 2 for Training Activities

As discussed in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices), the locations and numbers of training activities that use in-water electromagnetic devices would be identical under Alternatives 1 and 2. Although the numbers of annual activities under Alternatives 1 and 2 are the same, there is a slight increase in the number of activities proposed over five years. The increase in events does not measurably increase the probability for sea turtles to be exposed to electromagnetic energy; nor does it increase the potential for impacts on sea turtles to occur. As discussed for training activities that use electromagnetic devices under Alternative 1 (Section 3.8.3.3.1.1, Impacts from In-Water Electromagnetic Devices Under Alternative 1), sea turtles with the potential to co-occur with these training events remain the same, and potential impacts would be temporary and minor, and natural behavioral patterns would not be significantly altered or abandoned.

Pursuant to the ESA, the use of in-water electromagnetic devices during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles (because close proximity to an electromagnetic field may cause temporary disorientation or temporarily disrupt migratory direction).

Impacts from In-Water Electromagnetic Devices Under Alternative 2 for Testing Activities

As discussed in Section 3.0.3.3.3.1 (In-Water Electromagnetic Devices) the locations, numbers of testing activities, and potential effects associated with in-water electromagnetic device use would be the same under Alternatives 1 and 2. Refer to Section 3.8.3.3.1.1 (Impacts from In-Water Electromagnetic Devices Under Alternative 1) for a discussion of impacts on sea turtles.

Pursuant to the ESA, the use of in-water electromagnetic devices during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles (because close proximity to an electromagnetic field may cause temporary disorientation or temporarily disrupt migratory direction).

3.8.3.3.1.3 Impacts from In-Water Electromagnetic Devices Under the No Action Alternative

Impacts from In-Water Electromagnetic Devices Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various energy stressors (e.g., in-water electromagnetic devices) would not be introduced into the marine environment. Therefore baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.3.2 Impacts from In-Air Electromagnetic Devices

The use of in-air electromagnetic devices associated with Navy training and testing activities is not applicable to reptiles because in-air electromagnetic energy does not penetrate the ocean, nor will use of these devices be close enough in proximity to sea turtle nesting locations to have an effect on these animals. As a result, in-air electromagnetic devices will not be analyzed further in this section.

3.8.3.3.3 Impacts from High-Energy Lasers

As discussed in Section 3.0.3.3.3.3 (Lasers), high-energy laser weapons testing involves the use of up to 30 kilowatts of directed energy as a weapon against small surface vessels and airborne targets. These weapons systems are deployed from a surface ship to create small but critical failures in potential targets and used at short ranges from the target.

This section analyzes the potential impacts of high-energy lasers on sea turtles. Sea snakes were not included in the model—it is generally assumed that sea snake occurrence within the Study Area is very rare. Because of the low density of sea snakes in open ocean areas where high-energy laser testing would occur, sea snakes are assumed to not be impacted by high-energy laser strikes due to the extremely low likelihood of exposure. Therefore, sea snakes are not discussed further in the analysis for potential impacts on reptiles by testing activities using high-energy lasers.

The primary concern for high-energy weapons testing is the potential for a sea turtle to be struck by a high-energy laser beam at or near the water's surface, which could result in injury or death, resulting from traumatic burns from the beam.

Sea turtles could be exposed to a laser only if the beam missed the target. Should the laser strike the sea surface, individual sea turtles at or near the surface could be exposed. The potential for exposure to a high-energy laser beam decreases as the water depth increases. Because laser platforms are typically helicopters and ships, sea turtles at sea would likely transit away or submerge in response to other stressors, such as ship or aircraft noise, although some sea turtles may not exhibit a response to an oncoming vessel or aircraft, increasing the risk of contact with the laser beam.

3.8.3.3.3.1 Impacts from High-Energy Lasers Under Alternative 1

Impacts from High-Energy Lasers Under Alternative 1 for Training Activities

As shown in Table 3.0-14, no activities using high-energy lasers would occur as part of training activities. No impacts from high-energy lasers would occur under Alternative 1 training activities.

Impacts from High-Energy Lasers Under Alternative 1 for Testing Activities

As discussed in Section 3.0.3.3.3.3 (Lasers), high-energy laser use associated with testing activities would occur within the Hawaii Range Complex and Southern California Range Complex. Navy testing activities have the potential to expose sea turtles that occur within these areas to this energy stressor.

Appendix F (Military Expended Material and Direct Strike Impact Analyses) includes a conservative approach for estimating the probability of a direct laser strike on a sea turtle during testing and training activities. The Navy analysis assumes: (1) that all sea turtles would be at or near the surface 100 percent of the time, and would not account for the duration of time a sea turtle would be diving; and (2) that sea turtles are stationary, which does not account for any movement or any potential avoidance of the training or testing activity in response to other stressors (e.g., vessel noise).

The Navy compiled density data from several sources and developed a protocol to select the best available data sources based on species, area, time (season), and type of density model. The resulting GIS database, called the Navy Marine Species Density Database (U.S. Department of the Navy, 2017b), includes seasonal density values for sea turtle species present within the Study Area. When aerial surveys are used to collect data on sea turtle occurrence it is often difficult to distinguish between the different sea turtle species. To account for the known occurrence of multiple sea turtle species in the Study Area and the general lack of species-specific occurrence data for most species, a sea turtle guild, composed of green and hawksbill turtle sightings, was created to estimate sea turtle densities in the Hawaii Range Complex. The sea turtle guild was not used to estimate sea turtle densities in the transit corridor (eastern or western portions) or for the Southern California Range Complex due to the scarcity of sea turtle sightings data in these areas.

While the analysis of sea turtle guild survey data applies to all species, it is more reflective of green turtles, which account for nearly all sightings in the Hawaii Range Complex. The number of observations of hawksbill turtles would be so low as to render the data unusable for estimating density of this species. By considering the hawksbill and green turtle sightings together, a more powerful result can be provided for sea turtles as a guild. In theory, the guild also encompasses leatherback, olive ridley, and loggerhead turtles, but these species have not been identified during the collection of Navy monitoring data. The Navy's modeling results show a probability of 0.000064 strikes per year on a sea turtle. Based on the assumptions used in the statistical probability analysis, there is a high level of certainty in the conclusion that no sea turtle that occurs in the Study Area would be struck by a high-energy laser.

Pursuant to the ESA, the use of high-energy lasers during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.3.3.2 Impacts from High-Energy Lasers Under Alternative 2

Impacts from High-Energy Lasers Under Alternative 2 for Training Activities

As shown in Table 3.0-14, no activities using high-energy lasers would occur as part of training activities. No impacts from high-energy lasers would occur under Alternative 2 training activities.

Impacts from Lasers Under Alternative 2 for Testing Activities

The locations, number of events, and potential effects associated with high-energy laser use would be the same under Alternatives 1 and 2. Refer to Section 3.8.3.3.3.1 (Impacts from High-Energy Lasers Under Alternative 1) for a discussion of impacts on sea turtles.

Pursuant to the ESA, the use of high-energy lasers during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

3.8.3.3.3.3 Impacts from High-Energy Lasers Under the No Action Alternative

Impacts from Lasers Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various energy stressors (e.g., high-energy lasers) would not be introduced into the marine environment. Therefore baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.4 Physical Disturbance and Strike Stressors

This section analyzes the potential impacts of the various types of physical disturbance and strike stressors used by Navy during training and testing activities within the Study Area. The physical disturbance and strike stressors that may impact sea turtles and include: (1) Navy vessels; (2) in-water devices; (3) military expended materials, including non-explosive practice munitions and fragments from high-explosive munitions; and (4) seafloor devices. General discussion of impacts can also be found in Section 3.0.3.6.3 (Conceptual Framework for Assessing Effects from Physical Disturbance or Strike).

The way a physical disturbance may affect a sea turtle would depend in part on the relative size of the object, the speed of the object, the location of the sea turtle in the water column, and the behavioral reaction of the animal. It is not known at what point or through what combination of stimuli (visual, acoustic, or through detection in pressure changes) a sea turtle becomes aware of a vessel or other potential physical disturbances prior to reacting or being struck.

Like marine mammals, if a sea turtle reacts to physical disturbance, the individual must stop its activity and divert its attention in response to the stressor. The energetic costs of reacting to a stressor will depend on the specific situation, but one can assume that the caloric requirements of a response may reduce the amount of energy available for other biological functions. For sea turtles who have resident home ranges near Navy activities, the relative concentration of Navy vessels would cause sea turtles to respond repeatedly to the exposure. This repeated response would interrupt normal daily routines (e.g., foraging activities) more often than resident nearshore turtles not near Navy installations or in open ocean areas where Navy vessel traffic is less concentrated, though animals may become habituated to repeated stimuli. If a strike does occur, the cost to the individual could range from slight injury to death. Similarly, sea snakes, if struck, would likely experience injuries ranging from the slight to severe, with immediate mortality or reduced fitness that may result in death after the injury.

3.8.3.4.1 Impacts from Vessels and In-Water Devices

Vessels

The majority of the training and testing activities under all alternatives involve some level of vessel activity. For a discussion on the types of activities that use in-water devices see Appendix B (Activity Stressor Matrices). Section 3.0.3.3.4.1 (Vessels and In-Water Devices) Table 3.0-15 provides a list of representative vessels used in training and testing activities, along with vessel lengths and speeds used in training and testing activities.

Sea turtle strikes can cause permanent injury or death from bleeding or other trauma, paralysis and subsequent drowning, infection, or inability to feed. Apart from the severity of the physical strike, the likelihood and rate of a turtle's recovery from a strike may be influenced by its age, reproductive state, and general condition. Much of what is written about recovery from vessel strikes is inferred from observing individuals sometime after a strike. Numerous sea turtles bear scars that appear to have been caused by propeller cuts or collisions with vessel hulls (Hazel et al., 2007; Lutcavage & Lutz, 1997; Lutcavage et al., 1997). Fresh wounds on some stranded animals may strongly suggest a vessel strike as the cause of death. The actual incidence of recovery versus death is not known, given available data.

Sea turtles spend a majority of their time submerged (Renaud & Carpenter, 1994; Sasso & Witzell, 2006), though Hazel et al. (2009) and Hazel et al. (2007) showed most species of sea turtles staying within the top 3 m of water despite deeper water being available. Any of the sea turtle species found in the Study Area can occur at or near the surface in open ocean and coastal areas, whether feeding or periodically surfacing to breathe. Distribution of species is not uniform, however. Typically in Hawaii, loggerheads and olive ridleys are not seen in nearshore habitats because they are either transiting (relatively briefly occurring within nearshore waters) or are in more pelagic habitats. Similarly for San Diego Bay, green sea turtles are regularly seen within the bay, but not other species. Green sea turtles are the most abundant sea turtles found in the nearshore environment of the Study Area, and in Hawaii, are observed to bask on land. Loggerheads, considered to be the most generalist of sea turtle species in terms of feeding and foraging behavior, apparently exhibit varied dive behavior that is linked to the quantity and quality of available resources. Foley et al. (2011) found that loggerheads spent 7.3 percent of time at the surface (associated with breathing), 42 percent of time under the surface but close to the surface within one body length, and 44 percent of time within the water column (the remaining time observed at or near the seafloor). Leatherback sea turtles are more likely to feed at or near the surface in open ocean areas. It is important to note that leatherbacks can forage for jellyfish at depth but bring them to the surface to ingest (Benson et al., 2007; Fossette et al., 2007; James & Herman, 2001). Basking on the water's surface is common for all species within the Study Area as a strategy to thermoregulate, and the reduced activity associated with basking may pose higher risks for sea turtle strikes because of a likely reduced capacity to avoid cues. Green, hawksbill, and loggerhead sea turtles are more likely to forage nearshore, and although they may feed along the seafloor, they surface periodically to breathe while feeding and moving between nearshore habitats.

In an attempt to determine traffic patterns for Navy and non-Navy vessels, the Center for Naval Analysis (Mintz & Parker, 2006; Mintz, 2012) conducted a review of historic data for commercial vessels, coastal shipping patterns, and Navy vessels. Within the Hawaii portion of the HSTT Study Area, significant commercial traffic is present as vessels bring shipments of goods to Hawaii as well as shipments between the islands. Trans-Pacific vessel traffic that passes through offshore waters near Hawaii are associated with transits between Asian ports and ports along the U.S. west coast or the Panama Canal. Commercial and non-Navy traffic, which included cargo vessels, bulk carriers, passenger vessels, and oil tankers (all over 20 m in length), was heaviest along the U.S. West Coast between San Diego and Seattle (Puget Sound) and between the Hawaiian Islands and the Panama Canal (Mintz & Parker, 2006). Well-defined International shipping lanes within the Study Area are also heavily traveled. Compared to coastal vessel activity, there was relatively little concentration of vessels in the other portions of the Study Area (Mintz & Parker, 2006). Vessel traffic data from 2009 shows that Navy vessels accounted for less than 10 percent of the total large vessel traffic (from estimated vessel hours) in the Study Area (Mintz, 2012). In the Southern California Range Complex where Navy vessel activity is concentrated within the exclusive economic zone, the Navy vessels accounted for 24 percent of the total large vessel traffic (Mintz, 2012).

A total of 298 sea turtle strandings were reported in the Hawaiian Islands, from all causes between 1982 and 2007. Based on an observed annual average of eight green sea turtles stranded in the Main Hawaiian Islands between 1982 and 2007, and after applying a correction factor for those that do not strand, NMFS estimated 25–50 green sea turtles are killed by vessel strike annually in the Main Hawaiian Islands (National Marine Fisheries Service, 2008). A total of two hawksbill sea turtles were observed stranded with obvious boat strike injuries in the Main Hawaiian Islands between 1982 and 2008. The majority of strandings are likely the result of strikes with relatively small, but high speed fishing boats making thousands of trips through Hawaiian nearshore waters annually. As a term and condition for NMFS's Reinitiated Biological Opinion, the Navy prepared an analysis of all sea turtle strandings within the Hawaii Range Complex (National Marine Fisheries Service, 2015). The reinitiated consultation included additional sea turtle information, in waters within Pearl Harbor and near the Pearl Harbor entrance, as well as waters surrounding Oahu in order to improve the understanding of sea turtle strikes. The vast majority of the strandings were green sea turtles (96 percent) with the remaining reported as hawksbill sea turtles or unidentifiable sea turtles. Most of these strandings were from Oahu (approximately 70 percent). Of all reported strandings, 7 percent were attributed to vessel strike, with most (34 percent) from unspecified causes and 27 percent from fisheries interactions. The remainder were attributed to disease, predation, entrapment, and natural mortality (National Marine Fisheries Service, 2015).

The frequency of vessel strike in open ocean waters surrounding Hawaii is much less clear. It is assumed if an animal is struck in waters further from shore, it is less likely to strand and be documented. There has been one recent report of a stranded turtle in Hawaii that appeared as though it may have been struck by a large propeller (such as those used by some Navy vessels) (National Marine Fisheries Service, 2008). However, it is more likely turtles struck by large propellers would not strand because the damage to the carcass would be so extensive as to facilitate sinking or consumption by scavengers.

There is not a high level of sea turtle stranding data on the U.S. West Coast (National Marine Fisheries Service, 2008). This does not necessarily indicate vessel strike is less common off the U.S. West Coast versus Hawaii. Ocean currents, vessel sizes, or other factors may simply affect the likelihood a struck turtle will strand. Regardless, this lack of stranding data makes estimating the frequency of sea turtle vessel strike off the U.S. West Coast difficult. Most observations of stranded sea turtles in Southern California since 1990 occurred within San Diego Bay, where a population of green sea turtles resides. Between 1990 and 2014, 10 green sea turtle strandings were observed with evidence of boat collision (National Marine Fisheries Service, 2008). No other sea turtle species have stranded near or in the Southern California Range Complex that have had evidence of boat strike (National Marine Fisheries Service, 2008). As a term and condition for NMFS's Reinitiated Biological Opinion, the Navy prepared an analysis of all sea turtle strandings within Southern California for 2015. Only seven reported strandings of sea turtles were reported in 2015. Four of these strandings were green sea turtles, two were loggerheads, and one was olive ridley. Only three sea turtles were reported as struck by vessels, all of whom were green sea turtles. These strandings were reported within San Diego Bay and were located in areas that are not used by the Navy (National Marine Fisheries Service, 2015).

Disturbance of sea turtles from vessel movements is expected to occur with more frequency than actual strikes. Visual cues from vessels nearby and vessel noise would likely induce short-term behavioral changes, such as cessation of foraging activities or moving away from the disturbance.

In-Water Devices

In-water devices are generally smaller (several inches to 111 ft.) than most Navy vessels. For a discussion on the types of activities that use in-water devices see Appendix B (Activity Stressor Matrices), and for information on where in-water devices are used, and how many exercises would occur under each alternative, see Section 3.0.3.3.4.1 (Vessels and In-Water Devices).

Devices that could pose a collision risk to sea turtles are those operated at high speeds and are unmanned. The Navy reviewed torpedo design features and a large number of previous anti-submarine warfare torpedo exercises to assess the potential of torpedo strikes on marine mammals, and its conclusions are also relevant to sea turtles. The acoustic homing programs of Navy torpedoes are sophisticated and would not confuse the acoustic signature of a marine mammal with a submarine/target. It is reasonable to assume that acoustic signatures of sea turtles would also not be confused with a submarine or target. All exercise torpedoes are recovered and refurbished for eventual re-use. Review of the exercise torpedo records indicates there has never been an impact on a sea turtle. In thousands of exercises in which torpedoes were fired or in-water devices used, there have been no recorded or reported instances of a marine species strike from a torpedo or any other in-water device.

Since some in-water devices are identical to support craft, (typically less than 15 m in length), sea turtles could respond to the physical presence of the device similar to how they respond to the physical presence of a vessel (see Table 3.0-17). Physical disturbance from the use of in-water devices is not expected to result in more than a momentary behavioral response. These responses would likely include avoidance behaviors (swimming away or diving) and cessation of normal activities (e.g., foraging). As with an approaching vessel, not all sea turtles would exhibit avoidance behaviors and be at higher risk of a strike.

In-water devices, such as unmanned underwater vehicles, that move slowly through the water are highly unlikely to strike sea turtles because the turtle could easily avoid the object. Towed devices are unlikely to strike a sea turtle because of the observers on the towing platform and other standard safety measures employed when towing in-water devices. Sea turtles that occur in areas that overlap with in-water device use within the Study Area may encounter in-water devices. It is possible that sea turtles may be disturbed by the presence of these activities, but any disturbance from the use of in-water devices is not expected to result in more than a temporary behavioral response.

3.8.3.4.1.1 Impacts from Vessels and In-Water Devices Under Alternative 1

Section 3.0.3.3.4.1 (Vessels and In-Water Devices) provides estimates of relative vessel and in-water device use and location throughout the Study Area. Under Alternative 1 the concentration of vessel and in-water device use and the manner in which the Navy trains and tests would remain consistent with the levels and types of activity undertaken in the HSTT Study Area over the last decade. Consequently, the Navy does not foresee any appreciable changes in the levels, frequency, or locations where vessels have been used over the last decade and therefore the level which physical disturbance and strikes are expected to occur is likely to remain consistent with the previous decade.

Impacts from Vessels and In-Water Devices Under Alternative 1 for Training Activities

As indicated in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), most training activities involve vessel movement. The potential for vessel strikes to reptiles are not associated with any specific training activity but rather a limited, sporadic, and accidental result of Navy ship movement within the Study Area. Vessel movement can be widely dispersed throughout the HSTT Study Area but is more concentrated near naval ports, piers, and range areas. Navy training vessel traffic would especially be concentrated near Pearl Harbor and San Diego Bay. Smaller support craft usage would also be more concentrated in the coastal areas near naval installations, ports, and ranges.

As discussed in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), in-water devices include unmanned surface vehicles, unmanned underwater vehicles, and towed devices. Unmanned surface vehicle use would be concentrated within the Southern California Range Complex, with a relatively minor use in Pearl Harbor and waters off of Oahu.

Although the likelihood is low, a harmful interaction with a vessel or in-water device cannot be discounted, and sea turtle strikes in high vessel traffic areas (e.g., Pearl Harbor) have been reported. Potential impacts of exposure to vessels may result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for all sea turtle species. Under Alternative 1 training activities, the Navy will continue to implement procedural mitigation to avoid or reduce the potential for vessel and in-water device strike of sea turtles (see Section 5.3.4.1, Vessel Movement; and Section 5.3.4.2, Towed In-Water Devices). Within a mitigation zone of a vessel or in-water device, trained observers will relay sea turtle locations to the operators, who are required to change course (no course change would be implemented if the vessel's safety is threatened, the vessel is restricted in its ability to maneuver [e.g., during launching and recovery of aircraft or landing craft, during towing activities, when mooring, etc.], or if the vessel is operated autonomously. A mitigation zone size is not specified for sea turtles to allow flexibility based on vessel type and mission requirements (e.g., small boats operating in a narrow harbor). Sea snakes in the Study Area are not anticipated to occur within high vessel traffic areas, as the yellow-bellied sea snake is associated with pelagic habitats, and only in low abundances. Strikes of sea snakes are considered unlikely to occur.

Pursuant to the ESA, the use of vessels and in-water devices during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA. The Navy also consulted with the USFWS for the potential impacts of amphibious landing training activities on sea turtle nesting areas at the Pacific Missile Range Facility (PMRF) on Kauai. The USFWS concurred with the Navy's determination that amphibious landing activities at PMRF may affect but is not likely to adversely affect the green, hawksbill, and olive ridley sea turtles. Copies of agency correspondence are found in Appendix J (Agency Correspondence). Amphibious landings are not part of activities proposed in this EIS/OEIS.

Impacts from Vessels and In-Water Devices Under Alternative 1 for Testing Activities

As indicated in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), most of the testing activities involve large vessel movement. However, the number of activities that involve large vessel movements for testing is comparatively lower than the number of training activities. In addition, testing often occurs jointly with a training event, so it is likely that the testing activity would be conducted from a training vessel. Vessel movement in conjunction with testing activities could be widely dispersed throughout the Study Area, but would be concentrated near Pearl Harbor and San Diego Bay. Smaller support craft usage would also be more concentrated in the coastal areas near naval installations, ports, and ranges. There would be a higher likelihood of vessel strikes in these portions of the Study Area because of the concentration of vessel movement in those areas.

Propulsion testing events occur infrequently but pose a higher strike risk because of the higher speeds at which the vessels need to achieve in order to complete the testing activity. These activities could occur in the Hawaii Range Complex and Southern California Range Complex. However, there are just a few of these events proposed per year, so the increased risk is nominal compared to all vessel use proposed under Alternative 1.

As discussed in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), testing activities involving the use of in-water devices would occur in the HSTT Study Area at any time of year. Unmanned surface vehicle use would occur within both the Southern California and Hawaii portions of the HSTT Study Area.

As with training activities, the likelihood is low for testing activities to cause harmful interaction with a vessel or in-water device but cannot be wholly discounted. Sea turtle strikes in high vessel traffic areas (e.g., Pearl Harbor) have been reported. Potential impacts of exposure to vessels may result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Any strike at high speed is likely to result in significant injury. Potential impacts of exposure to vessels are not expected to result in population-level impacts for all sea turtle species. Under Alternative 1 testing activities, the Navy will continue to implement procedural mitigation to avoid or reduce the potential for vessel and in-water device strike of sea turtles (see Section 5.3.4.1, Vessel Movement; and Section 5.3.4.2, Towed In-Water Devices). Within a mitigation zone of a vessel or in-water device, trained observers will relay sea turtle locations to the operators, who are required to change course (no course change would be implemented if the vessel's safety is threatened, the vessel is restricted in its ability to maneuver [e.g., during launching and recovery of aircraft or landing craft, during towing activities, when mooring, etc.], or if the vessel is operated autonomously). A mitigation zone size is not specified for sea turtles to allow flexibility based on vessel type and mission requirements (e.g., small boats operating in a narrow harbor).

Pursuant to the ESA, the use of vessels and in-water devices during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.4.2 Impacts from Vessels and In-Water Devices Under Alternative 2

Impacts from Vessels and In-Water Devices Under Alternative 2 for Training Activities

Because training activities under Alternative 2 occur at a similar rate and frequency relative to Alternative 1, physical disturbance and strike stress experienced by reptiles from vessels and in-water device use under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. Therefore, impacts associated with training and testing activities under Alternative 2 are the same as Alternative 1.

Pursuant to the ESA, the use of vessels and in-water devices during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

Impacts from Vessels and In-Water Devices Under Alternative 2 for Testing Activities

Because testing activities under Alternative 2 occur at a similar rate and frequency relative to Alternative 1, physical disturbance and strike stress experienced by reptiles from vessels and in-water device use under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. Therefore, impacts associated with training and testing activities under Alternative 2 are the same as Alternative 1.

As shown in Table 3.0-18, in-water device use under Alternative 2 would be almost identical to what is proposed annually for testing activities under Alternative 1 for the Southern California portion and Hawaii portion of the HSTT Study Area; there is no change in the proposed number for the Transit Corridor portions of the Study Area. This level of increased use of in-water devices would increase the potential for physical disturbance or strike of a sea turtle in the Southern California portion of the HSTT Study Area. As discussed in Section 3.0.3.3.4.1 (Vessels and In-Water Devices), testing activities involving the use of in-water devices would occur in the HSTT Study Area at any time of year. Unmanned surface vehicle use would occur within both the Southern California and Hawaii portions of the HSTT Study Area.

Pursuant to the ESA, the use of vessels and in-water devices during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

3.8.3.4.2.1 Impacts from Vessels and In-Water Devices Under the No Action Alternative

Impacts from Vessels and In-Water Devices Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Physical disturbance and strike stressors (e.g., vessels and in-water devices) would not be introduced into the marine environment. Therefore baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.4.3 Impacts from Aircraft and Aerial Targets

Impacts from aircraft and aerial targets are not applicable to sea turtles or sea snakes because they do not occur in airborne environments and will not be analyzed further in this section. Refer to the Impacts from Military Expended Materials section (Section 3.8.3.4.4) for impacts from target fragments and the Acoustic Stressors section (Section 3.8.3.1) for potential disturbance from aircraft.

3.8.3.4.4 Impacts from Military Expended Materials

This section analyzes the strike potential to sea turtles from the following categories of military expended materials: (1) all sizes of non-explosive practice munitions; (2) fragments from high-explosive munitions; (3) expendable targets; and (4) expended materials other than munitions, such as sonobuoys, expended bathythermographs, and torpedo accessories. For a discussion of the types of activities that use military expended materials refer to Appendix B (Activity Stressor Matrices) and for a discussion on where they are used and how many exercises would occur under each alternative, see Section 3.0.3.3.4.2 (Military Expended Materials). As described in Appendix F (Military Expended Material and Direct Strike Impact Analyses), for physical disturbance and strike stressors as it relates to sea turtles, impacts from fragments from high-explosive munitions are included in the analysis presented in Section 3.8.3.2 (Explosive Stressors), and are not considered further in this section. Sea snakes are not modeled for potential strikes because of their low numbers in the Study Area and a lack of density information to provide quantifiable estimations of strike impacts. Therefore, only sea turtles are considered in this analysis.

The primary concern is the potential for a sea turtle to be struck with a military expended material at or near the water's surface, which could result in injury or death. For sea turtles, although disturbance or strike from an item as it falls through the water column is possible, it is not likely because the objects generally sink through the water slowly and can be avoided by most sea turtles. Materials will slow in their velocity as they approach the bottom of the water and will likely be avoided by any juvenile or adult sea turtles (e.g., olive ridley, green, loggerhead, or hawksbill turtles) that happen to be in the vicinity foraging in benthic habitats. Therefore, the discussion of military expended materials strikes focuses on the potential of a strike at the surface of the water.

There is a possibility that an individual turtle at or near the surface may be struck if they are in the target area at the point of physical impact at the time of non-explosive munitions delivery. Expended munitions may strike the water surface with sufficient force to cause injury or mortality. Adult sea turtles are generally at the surface for short periods, and spend most of their time submerged; however, hatchlings and juveniles spend more time at the surface while in ocean currents or at the surface while basking. The leatherback sea turtle is more likely to be foraging at or near the surface in the open ocean than other species, but the likelihood of being struck by a projectile remains very low because of the wide spatial distribution of leatherbacks relative to the point location of an activity. Furthermore, projectiles are aimed at targets, which will absorb the impact of the projectile.

While no strike from military expended materials has ever been reported or recorded on a reptile, the possibility of a strike still exists. Therefore, the potential for sea turtles to be struck by military expended materials was evaluated using statistical probability modeling to estimate potential direct strike exposures to a sea turtle. To estimate potential direct strike exposures, a worst-case scenario was calculated using the sea turtle with the highest average year-round density in areas with the highest military expended material expenditures in the Hawaii and Southern California portions of the HSTT Study Area (see Appendix F, Military Expended Material and Direct Strike Impact Analyses). The green sea turtle was used as a proxy for all sea turtle species because this species has the highest density estimates, which would provide the most conservative modeling output results. For estimates of expended materials in all areas, see Section 3.0.3.3.4.2 (Military Expended Materials). Input values include munitions data (frequency, footprint and type), size of the training or testing area, sea turtle density data, and size of the animal. To estimate the potential of military expended materials to strike a sea turtle, the impact area of all military expended materials was totaled over one year in the area with the highest combined amounts of military expended materials for the Proposed Action. The analysis of the potential for a sea turtle strike is influenced by the following assumptions:

- The model is two-dimensional, assumes that all sea turtles would be at or near the surface 100 percent of the time, and does not consider any time a sea turtle would be submerged.

- The model also does not take into account the fact that most of the projectiles fired during training and testing activities are fired at targets, and that most projectiles hit those targets, so only a very small portion of those would hit the water with their maximum velocity and force.
- The model assumes the animal is stationary and does not account for any movement of the sea turtle or any potential avoidance of the training or testing activity.

The potential of fragments from high-explosive munitions or expended material other than munitions to strike a sea turtle is likely lower than for the worst-case scenario calculated above because those events happen with much lower frequency. Fragments may include metallic fragments from the exploded target, as well as from the exploded munitions.

There is a possibility that an individual turtle at or near the surface may be struck if they are in the target area at the point of physical impact at the time of non-explosive munitions delivery. Expended munitions may strike the water surface with sufficient force to cause injury or mortality. Direct munitions strikes from non-explosive bombs, missiles, and rockets are potential stressors to some species. Some individuals at or near the surface may be struck directly if they are at the point of impact at the time of non-explosive practice munitions delivery. However, most missiles hit their target or are disabled before hitting the water. Thus, most of these missiles and aerial targets hit the water as fragments, which quickly dissipates their kinetic energy within a short distance of the surface.

Adult sea turtles are generally at the surface for short periods and spend most of their time submerged; however, hatchlings and juveniles of all sea turtle species spend more time at the surface while in ocean currents, and all sea turtle life stages bask on the surface. Leatherback sea turtles of all age classes are more likely to be foraging at or near the surface in the open ocean than other species, but the likelihood of being struck by a projectile remains very low because of the wide spatial distribution of leatherbacks relative to the point location of an activity. Furthermore, projectiles are aimed at targets, which will absorb the impact of the projectile. Other factors that further reduce the likelihood of a sea turtle being struck by an expended munition include the recovery of all non-explosive torpedoes as well as target-related materials that are intact after the activity. The Navy will implement mitigation (e.g., not conducting gunnery activities against a surface target when a specified distance from sea turtles) to avoid potential impacts from military expended materials on sea turtles throughout the Study Area (see Section 5.3, Procedural Mitigation to be Implemented).

3.8.3.4.4.1 Impacts from Military Expended Materials Under Alternative 1

Impacts from Military Expended Materials Under Alternative 1 for Training Activities

Training activities in offshore waters that involve military expended materials under Alternative 1 would occur in the Hawaii Range Complex, Southern California Range Complex, and the Transit Corridor. The model results presented in Appendix F (Military Expended Material and Direct Strike Impact Analyses) estimate sea turtle exposures (as discussed above, green sea turtles were used as a conservative proxy for all sea turtle species). The results indicate with a reasonable level of certainty that sea turtles would not be struck by non-explosive practice munitions and expended materials other than munitions. In the Hawaii Range Complex, the model estimates approximately 0.008 exposures per year. Again, to consider the most conservative of outcomes, only density estimates in the Hawaii Range Complex were used because in these waters, sea turtles occur in the highest numbers year round (in contrast to waters off of southern California, where sea turtle occurrence is more seasonal).

As stated previously, factors that further reduce the likelihood of a sea turtle being struck by an expended munition include the recovery of all non-explosive torpedoes as well as target-related materials that are intact after the activity. The Navy will implement mitigation (e.g., not conducting gunnery activities against a surface target when a specified distance from sea turtles) to avoid potential impacts from military expended materials on sea turtles throughout the Study Area. Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats; however, the likelihood of impact is lower for these age classes due to their occurrence at or near the water surface by concentrated algal mats. Activities will not be initiated near concentrated algal mats due to the possible presence of sea turtles (see Section 5.3, Procedural Mitigation to be Implemented).

Pursuant to the ESA, the use of military expended materials during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Military Expended Materials Under Alternative 1 for Testing Activities

Testing activities in offshore waters that involve military expended materials under Alternative 1 would occur in the Hawaii Range Complex, Southern California Range Complex, and the Transit Corridor. Based on a worst-case scenario, the results indicate with a reasonable level of certainty that sea turtles would not be struck by non-explosive practice munitions and expended materials other than munitions. The model results presented in Appendix F (Military Expended Material and Direct Strike Impact Analyses) estimate sea turtle exposures (as discussed above, green sea turtles used as a conservative proxy for all sea turtle species). In the Hawaii Range Complex, the model estimates approximately 0.009 exposures per year. Again, to consider the most conservative of outcomes, only density estimates in the Hawaii Range Complex were used because in these waters, sea turtles occur in the highest numbers year round (in contrast to waters off of southern California, where sea turtle occurrence is more seasonal). No modeling was conducted for activities within the transit corridor.

As with training activities, factors that further reduce the likelihood of a sea turtle being struck by an expended munition used during testing activities include the recovery of all non-explosive torpedoes as well as target-related materials that are intact after the activity. The Navy will implement mitigation (e.g., not conducting gunnery activities against a surface target when a specified distance from sea turtles) to avoid potential impacts from military expended materials on sea turtles throughout the Study Area. Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats; however, the likelihood of impact is lower for these age classes due to their occurrence at or near the water surface by concentrated algal mats. Activities will not be initiated near concentrated algal mats due to the possible presence of sea turtles (see Section 5.3, Procedural Mitigation to be Implemented).

Pursuant to the ESA, the use of military expended materials during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.4.4.2 Impacts from Military Expended Materials Under Alternative 2

Impacts from Military Expended Materials Under Alternative 2 for Training Activities

Training activities under Alternative 2 would involve the same amount of non-explosive practice munitions and fragments from high-explosive munitions for all locations in the Study Area as what is proposed under Alternative 1. As shown in Section 3.0.3.3.4.2 (Military Expended Materials), there would be an increase in the use of sonobuoys and other military materials during training under Alternative 2 within the Study Area. Results from strike calculations conducted under Alternative 2 training activities would not be meaningfully different from results calculated under Alternative 1; therefore, the conclusions for Alternative 2 training activities would be the same as for Alternative 1 training activities.

Pursuant to the ESA, the use of military expended materials during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

Impacts from Military Expended Materials Under Alternative 2 for Testing Activities

Probability analysis results in Appendix F (Military Expended Material and Direct Strike Impact Analyses) indicates that the minor increase in the amount of expended materials proposed under Alternative 2 does not result in any substantial increase in the risk that a sea turtle would be struck by a military expended material. Therefore the associated impacts on sea turtles are expected to be similar to Alternative 1 and the analyses presented in Section 3.8.3.4.4.1 (Impacts from Military Expended Materials Under Alternative 1) for testing activities would be applicable to military expended materials associated with testing activities under Alternative 2.

Pursuant to the ESA, the use of military expended materials during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

3.8.3.4.4.3 Impacts from Military Expended Materials Under the No Action Alternative

Impacts from Military Expended Materials Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Physical disturbance and strike stressors (e.g., military expended materials) would not be introduced into the marine environment. Therefore baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.4.5 Impacts from Seafloor Devices

For a discussion of the types of activities that use seafloor devices refer to Appendix B (Activity Stressor Matrices) and for a discussion on where they are used and how many exercises would occur under each alternative, see Section 3.0.3.3.4.3 (Seafloor Devices). These include items placed on, dropped on or moved along the seafloor such as mine shapes, anchor blocks, anchors, bottom-placed instruments, and bottom-crawling unmanned underwater vehicles. The likelihood of any sea turtle species encountering seafloor devices is considered low because these items are either stationary or move very slowly along the bottom. A benthic-foraging sea turtle would likely avoid the seafloor device. In the unlikely event that a sea turtle is in the vicinity of a seafloor device, the slow movement and stationary characteristics of these devices would not be expected to physically disturb or alter natural behaviors of sea turtles. As discussed in Section 3.8.3.4.4 (Impacts from Military Expended Materials), objects falling through the water column will slow in velocity as they sink toward the bottom and could be avoided by most sea turtles. Therefore, these items do not pose a significant strike risk to sea turtles. The only seafloor device used during training and testing activities that has the potential to strike a sea turtle at or near the surface is an aircraft deployed mine shape, which is used during aerial mine laying activities. These devices are identical to non-explosive practice bombs, therefore the analysis of the potential impacts from those devices are covered in Section 3.8.3.4.4 (Impacts from Military Expended Materials) and are not further analyzed in this section.

3.8.3.4.5.1 Impacts from Seafloor Devices Under Alternative 1

The number and location of activities including seafloor devices is presented in Section 3.0.3.3.4.3 (Seafloor Devices). Additional information on stressors by testing and training activity is provided in Appendix B (Activity Stressor Matrices). Seafloor devices include items that are placed on, dropped on, or moved along the seafloor, such as mine shapes, anchor blocks, anchors, bottom-placed instruments, bottom-crawling unmanned underwater vehicles, and bottom-placed targets that are not expended. As discussed in the military expended materials strike section, objects falling through the water column would slow in velocity as they sink toward the bottom and could be avoided by most, if not all, sea turtles.

Impacts from Seafloor Devices Under Alternative 1 for Training Activities

Table 3.0-27 shows the number and location of activities that use seafloor devices. As indicated in Section 3.0.3.3.4.3 (Seafloor Devices), activities that use seafloor devices occur in Hawaii and Southern California Range Complexes. Based on the analysis in Section 3.8.3.4.4.1 (Impacts from Military Expended Materials Under Alternative 1) for training activities, there is a reasonable level of certainty that no sea turtles would be struck by seafloor devices. The likelihood of a sea turtle encountering seafloor devices in benthic foraging habitats is considered low because these items are either stationary or move very slowly along the bottom. Seafloor devices are not likely to interfere with sea turtles resident to, or engaging in migratory, reproductive, and feeding behaviors within the range complexes of the HSTT Study Area. Further, seafloor devices would only impact sea turtle species that are foraging in benthic habitats (e.g., olive ridley, loggerhead, and green sea turtles). Sea turtles in coastal habitats can occur near the bottom when foraging or resting. Sea turtles encountering seafloor devices would likely to avoid them because of their slow movement and visibility. Given the slow movement of seafloor devices, the effort expended by sea turtles to avoid them will be minimal, temporary, and not have fitness consequences.

Pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Seafloor Devices Under Alternative 1 for Testing Activities

As described above for training activities, Table 3.0-27 provides the number and location of activities that use seafloor devices in Hawaii and Southern California Range Complexes. Section 3.0.3.3.4.3 (Seafloor Devices) discusses the types of activities that use seafloor devices, where they are used, and how many events will occur under Alternative 1. The likelihood of a sea turtle encountering seafloor devices in benthic foraging habitats is considered low because these items are either stationary or move very slowly along the bottom. Seafloor devices are not likely to interfere with sea turtles resident to, or engaging in migratory, reproductive, and feeding behaviors within the range complexes of the Study Area. Further, seafloor devices would only impact sea turtle species that are foraging in benthic habitats (i.e., loggerhead, and green sea turtles). Any sea turtle species found in the Study Area can occur at or near the surface in open-ocean and coastal areas, whether feeding or periodically surfacing to breathe. Additionally, sea turtles in coastal habitats can occur near the bottom when foraging or resting. Sea turtles encountering seafloor devices are likely to behaviorally avoid them. Given the slow movement of seafloor devices, the effort expended by sea turtles to avoid them will be minimal, temporary, and not have fitness consequences.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.4.5.2 Impacts from Seafloor Devices Under Alternative 2

Impacts from Seafloor Devices Under Alternative 2 for Training Activities

As presented in Section 3.0.3.3.4.3 (Seafloor Devices; Table 3.0-27) the locations and annual number of training activities that involve seafloor devices are the same for Alternatives 1 and 2 within the Hawaii portion of the HSTT Study Area and within the Southern California portion of the HSTT Study Area they decrease by an insignificant number. Therefore the impacts on sea turtles for the use of seafloor devices under Alternative 2 are expected to be the similar to Alternative 1 and as presented in Section 3.8.3.4.5.1 (Impacts from Seafloor Devices Under Alternative 1).

Pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

Impacts from Seafloor Devices Under Alternative 2 for Testing Activities

As presented in Section 3.0.3.3.4.3 (Seafloor Devices; Table 3.0-27) the locations and annual number of testing activities that involve seafloor devices are the same for Alternatives 1 and 2 within the Hawaii portion of the HSTT Study Area and within the Southern California portion of the HSTT Study Area they increase by an insignificant number. Therefore the impacts on sea turtles for the use of seafloor devices under Alternative 2 are expected to be the similar to Alternative 1 and as presented in Section 3.8.3.4.5.1 (Impacts from Seafloor Devices Under Alternative 1)

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

3.8.3.4.5.3 Impacts from Seafloor Devices Under the No Action Alternative

Impacts from Seafloor Devices Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Physical disturbance and strike stressors (e.g., seafloor devices) would not be introduced into the marine environment. Therefore baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.5 Entanglement Stressors

This section analyzes the potential entanglement impacts of the various types of expended materials used by the Navy during training and testing activities within the Study Area. This analysis includes the potential impacts of three types of military expended materials, including: (1) wires and cables, (2) decelerators/parachutes, and (3) biodegradable polymers. The number and location of training and testing exercises that involve the use of items that may pose an entanglement risk are provided in Section 3.0.3.3.5 (Entanglement Stressors). General discussion of impacts can also be found in Section 3.0.3.6.4 (Conceptual Framework for Assessing Effects from Entanglement).

These materials could be encountered by and if encountered, may have the potential to entangle sea turtles in the HSTT Study Area at the surface, in the water column, or along the seafloor. Sea snakes are not analyzed for potential entanglement stressors because of their physiology and lack of appendages that increase the likelihood of an entanglement interaction. Although the main threat to sea snakes globally is fisheries bycatch, this is primarily associated with prawn fisheries (using drag nets). Therefore, the impact analysis for entanglement stressors is limited to sea turtles. Risk factors for entanglement of sea turtles include animal size (and life stage), sensory capabilities, and foraging methods. Most entanglements discussed in the literature are attributable to sea turtle entrapments with fishing gear or other non-military materials that float or are suspended at the surface.

As described in Section 3.0.3.3.5.3 (Biodegradable Polymer), 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 designed to entangle the propellers of in-water vessels. Marine Vessel Stopping payload systems designed to entangle the propellers of small in-water vessels would only be used during testing activities, not during training (Table 3.0-32).

Entanglement events are difficult to detect from land or from a boat as they may occur at considerable distances from shore and typically take place underwater. Juvenile turtles are inherently less likely to be detected than larger adult sea turtles. The likelihood of witnessing an entanglement event is therefore typically low. However, the properties and size of these military expended materials, as described in Section 3.0.3.3.5 (Entanglement Stressors) and Section 3.0.3.6.4 (Conceptual Framework for Assessing Effects from Entanglement), makes entanglement unlikely.

3.8.3.5.1 Impacts from Wires and Cables

For a discussion of the types of activities that use wires and cables see Appendix B (Activity Stressor Matrices) and for a discussion on where they are used and how many exercises would occur under each alternative, see Section 3.0.3.3.5.1 (Wires and Cables). A sea turtle that becomes entangled in nets, lines, ropes, or other foreign objects under water may suffer temporary hindrance to movement before it frees itself or the sea turtle may remain entangled. The turtle may suffer minor injuries but recover fully, or it may die as a result of the entanglement. The entanglement risk to sea turtles are discussed below.

Fiber optic cables are flexible cables that can range in size up to 3,000 m in length. Longer cables present a higher likelihood of sea turtle interactions, and therefore present an increased risk of entanglement of a sea turtle. Other factors that increase risk of sea turtle interactions with fiber optic cables include the amount of time a fiber optic cable is in the same vicinity of a sea turtle; however, these cables will only be within the water column during the activity and while they sink, the likelihood of a sea turtle encountering and becoming entangled within the water column is extremely low. Fiber optic cables exhibit several physical qualities that reduce the risk of entanglement. Primarily, these cables are brittle and break easily. Because of the physical properties of fiber optic material, the cable is brittle and easily broken when kinked, twisted, or bent sharply. The cables are often designed with controlled buoyancy to minimize the cable's effect on vehicle movement. The fiber optic cable would be suspended within the water column during the activity, and then be expected to sink to the seafloor. Further, activities that use fiber optic cables occur in deep waters. These factors reduce the likelihood that a fiber optic cable would be in close proximity to a sea turtle—the cable is only buoyant during the training and testing activity, and subsequently sinks after use to rest in benthic habitats. If the isobaths is greater than the maximum benthic foraging ability (dive depth) of a sea turtle, then these cables would not present an entanglement risk. For example, as discussed previously, leatherbacks may dive to depths greater than 1,000 m in search of prey (e.g., jellyfish), while other species (e.g., loggerheads) may forage in benthic habitats as deep as approximately 200 m, and juvenile sea turtles (e.g., green sea turtles) resting and foraging in waters as deep as approximately 30 (Hochscheid, 2014; Rieth et al., 2011). In addition, because of the physical properties of the fiber optic material, the cable is unlikely to entangle a sea turtle body or appendage because the cable would likely break before an entangling loop would form. If a loop did form around an appendage or sea turtle body, the cable would subsequently break quickly on its own or in response to sea turtle movement. Therefore, fiber optic cables present an entanglement risk to sea turtles, but it is unlikely that an entanglement event would occur and any entanglement would be temporary (a few seconds) before the sea turtle could resume normal activities. As noted in Section 3.8.2.1.5 (General Threats), entanglement by fishing gear is a serious global threat to sea turtles. The various types of marine debris attributed to sea turtle entanglement (e.g., commercial fishing gear, towed gear, stationary gear, or gillnets) have substantially higher (up to 500–2,000 lb.) breaking strengths at their "weak links." If fiber optic cables and fragments of cables sink to the seafloor in an area where the bottom is calm, they would remain there undisturbed. In an area with bottom currents or active tidal influence, the fiber optic strands may move along the seafloor, away from the location in which they were expended and potentially into sea turtle benthic foraging habitats. Over time, these strands may become covered by sediment in most areas or colonized by attaching and encrusting organisms, which would further stabilize the material and reduce the potential for reintroduction as an entanglement risk.

Similar to fiber optic cables discussed above, guidance wires may pose an entanglement threat to sea turtles either in the water column or after the wire has settled to the seafloor. The Navy previously analyzed the potential for entanglement of sea turtles by guidance wires and concluded that the potential for entanglement is low (U.S. Department of the Navy, 1996). These conclusions have also been carried forward in NMFS analyses of Navy training and testing activities (National Marine Fisheries Service, 2013). The likelihood of a sea turtle encountering and becoming entangled in a guidance wire depends on several factors. With the exception of a chance encounter with the guidance wire while it is sinking to the seafloor (at an estimated rate of 0.7 ft. per second), it is most likely that a sea turtle would only encounter a guidance wire once it had settled on the seafloor. Since the guidance wire will only be within the water column during the activity and while it sinks, the likelihood of a sea turtle encountering and becoming entangled within the water column is extremely low. Guidance wires have a relatively low tensile breaking strength; between 10 and 42 lb. and can be broken by hand (National Marine Fisheries Service, 2008). In addition, based on degradation times, the guidance wires would break down within one to two years and therefore no longer pose an entanglement risk. As with fiber optic cables, guidance wire fragments may move with bottom currents or active tidal influence, and present an enduring entanglement risk if the wires were moved into benthic foraging habitats. Subsequent colonization by encrusting organisms, burying by sediment, and chemical breakdown of the copper filament would further reduce the potential for reintroduction as an entanglement risk. The length of the guidance wires varies, as described in Section 3.0.3.3.5.1 (Wires and Cables), but greater lengths increase the likelihood that a sea turtle could become entangled. The behavior and feeding strategy of a species can determine whether it may encounter items on the seafloor, where guidance wires will most likely be available. There is potential for those species that feed on the seafloor to encounter guidance wires and potentially become entangled; however, the relatively few guidance wires being expended within the HSTT Study Area limits the potential for encounters.

Sonobuoys consist of a surface antenna and float unit and a subsurface hydrophone assembly unit. The two units are attached through a thin-gauge, dual-conductor, hard draw copper strand wire, which is then wrapped by a hollow rubber tubing or bungee in a spiral configuration. The tensile breaking strength of the sonobuoy wire and rubber tubing is no more than 40 lb. The length of the sonobuoy wire is housed in a plastic canister dispenser, which remains attached upon deployment. The length of cable that extends out is no more than 1,500 ft. and is dependent on the water depth and type of sonobuoy. Attached to the sonobuoy wire is a kite-drogue and damper disk stabilizing system made of non-woven nylon fabric. The nylon fabric is very thin and can be broken by hand. The sonobuoy wire runs through the stabilizing system and leads to the hydrophone components. The hydrophone components may be covered by thin plastic netting depending on type of sonobuoy. Each sonobuoy has a saltwater activated polyurethane float that inflates when the sonobuoy is submerged and keeps the sonobuoy components floating vertically in the water column below it. Sonobuoys remain suspended in the water column for no more than 30 hours, after which they sink to the seafloor. Several factors reduce the likelihood of sea turtle entanglement from sonobuoy components. The materials that present an entanglement risk in sonobuoys are weak, and if wrapped around an adult or juvenile sea turtle, would likely break soon after entanglement or break while bending into potentially entangling loops, although hatchlings would not likely be able to escape entrapment if entangled. These materials, however, are only temporarily buoyant and would begin sinking after use in an activity. The entanglement risk from these components would only occur when a sea turtle and these components were in close proximity, which is only in the water column. These materials would be expended in waters too deep for benthic foraging, so bottom foraging sea turtles would not interact with these materials once they sink. Some sonobuoy components, once they sink to the bottom, may be transported by bottom currents or active tidal influence, and present an enduring entanglement risk. In the benthic environment, subsequent colonization by encrusting organisms, burying by sediment, and chemical breakdown of the various materials would further reduce the potential for reintroduction as an entanglement risk.

3.8.3.5.1.1 Impacts from Wires and Cables Under Alternative 1

Impacts from Wires and Cables Under Alternative 1 for Training Activities

Training activities under Alternative 1 would expend wires and cables throughout the Study Area.

Based on the numbers and geographic locations of their use, wires and cables used during training activities are analyzed for their potential to entangle sea turtles. Any species of sea turtle that occurs in the Study Area could at some time encounter expended cables or wires. The sink rates of cables and wires would rule out the possibility of these drifting great distances into nearshore and coastal areas where green, hawksbill, olive ridley, and loggerhead sea turtles are more likely to occur and feed on the bottom. The leatherback is more likely to co-occur with these activities, given its preference for open-ocean habitats, but this species is known to forage on jellyfish at or near the surface. Hatchlings and juveniles of some sea turtle species (e.g. greens and loggerheads), may occur in open-ocean habitats, too. Under Alternative 1, exposure to cables and wires used in training activities may cause short-term or long-term disturbance to an individual turtle because if a sea turtle were to become entangled in a cable or wire, it could free itself, or the entanglement could lead to injury or death. Potential impacts of exposure to cable or wire may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, wires and cables are generally not expected to cause disturbance to sea turtles because (1) sea turtles would only be exposed to potential entanglement risk as the wire or cable sinks through the water column; (2) due to their behavior, sea turtles are unlikely to become entangled in an object that is resting on the seafloor, and (3) there is a low concentration of expended wires and cables in the HSTT study area. Therefore, it is unlikely that an individual sea turtle would be in close proximity to a sinking wire or cable, and if so, would unlikely become entangled. Potential impacts of exposure to cables and wires are not expected to result in population-level impacts.

Pursuant to the ESA, the use of wires and cables during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Wires and Cables Under Alternative 1 for Testing Activities

Testing activities under Alternative 1 would expend wires and cables within the Hawaii Range Complex and the Southern California Range Complex.

Based on the numbers and geographic locations of their use, wires and cables used during testing activities are analyzed for their potential to entangle sea turtles. Any species of sea turtle that occurs in the Study Area could at some time encounter expended cables or wires. The sink rates of cables and wires would rule out the possibility of these drifting great distances into nearshore and coastal areas where green, hawksbill, olive ridley, and loggerhead sea turtles are more likely to occur and feed on the bottom. The leatherback sea turtle is more likely to co-occur with these activities, given its preference for open-ocean habitats, but this species is known to forage on jellyfish at or near the surface. Under Alternative 1, exposure to cables and wires used in testing activities may cause short-term or long-term disturbance to an individual turtle because if a sea turtle were to become entangled in a cable or wire, it could free itself, or the entanglement could lead to injury or death. Potential impacts of exposure to cable or wire may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, cables and wires are generally not expected to cause disturbance to sea turtles because of (1) the physical characteristics of the cables and wires, and (2) the behavior of the species, as sea turtles are unlikely to become entangled in an object that is resting on the seafloor. Potential impacts of exposure to cables and wires are not expected to result in population-level impacts.

Pursuant to the ESA, the use of wires and cables during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.5.1.2 Impacts from Wires and Cables Under Alternative 2

Impacts from Wires and Cables Under Alternative 2 for Training Activities

The locations of training activities that expend wires and cables are the same under Alternatives 1 and 2. Table 3.0-29 shows the number and location of wires and cables expended during proposed training activities. Even though training activities under Alternative 2 occur at a slightly higher rate and frequency relative to Alternative 1, entanglement stress experienced by reptiles from guidance wires, fiber optic cables, and sonobuoy wires under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. The number of sonobuoys would increase under Alternative 2 training activities, thereby increasing the number of sonobuoy wires expended into the marine environment. However, wires and cables are generally not expected to cause disturbance to sea turtles because (1) sea turtles would only be exposed to potential entanglement risk as the wire or cable sinks through the water column; (2) due to their behavior, sea turtles are unlikely to become entangled in an object that is resting on the seafloor; and (3) there is a low concentration of expended wires and cables in the HSTT study area. Therefore, it is unlikely that an individual sea turtle would be in close proximity to a sinking wire or cable, and if so, would unlikely become entangled. Potential impacts of exposure to cables and wires are not expected to result in population-level impacts. Further, the differences in species overlap and potential impacts from wires and cables on sea turtles during training activities would not be discernible from those described for training activities in Section 3.8.3.5.1.1 (Impacts from Wires and Cables Under Alternative 1). As with Alternative 1, the use of wires and cables in training activities may cause short-term or long-term disturbance to an individual turtle, because if a sea turtle were to become entangled in a cable or wire, it could free itself or the entanglement could lead to injury or death. Potential impacts of exposure to cable or wire may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Potential impacts of exposure to cables and wires are not expected to result in population-level impacts.

Pursuant to the ESA, the use of wires and cables during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

Impacts from Wires and Cables Under Alternative 2 for Testing Activities

The locations of testing activities that expend wires and cables are the same under Alternatives 1 and 2. Table 3.0-30 shows the number and location of wires and cables expended during proposed testing activities. Even though testing activities under Alternative 2 occur at a slightly higher rate and frequency relative to Alternative 1, entanglement stress experienced by reptiles from guidance wires, fiber optic cables, and sonobuoy wires under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. As with Alternative 1, the use of wires and cables in testing activities may cause short-term or long-term disturbance to an individual turtle, because if a sea turtle were to become entangled in a cable or wire, it could free itself or the entanglement could lead to injury or death. Potential impacts of exposure to a cable or wire may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Potential impacts of exposure to cables and wires are not expected to result in population-level impacts.

Pursuant to the ESA, the use of wires and cables during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

3.8.3.5.1.3 Impacts from Wires and Cables Under the No Action Alternative

Impacts from Wires and Cables Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various entanglement stressors (e.g., wires and cables) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.5.2 Impacts from Decelerators/Parachutes

Section 3.0.3.3.5.2 (Decelerators/Parachutes) provides the number of training and testing exercises that involve the use of decelerators/parachutes and the geographic areas where they would be expended. Training and testing activities that introduce decelerators/parachutes into the water column can occur anywhere in the HSTT Study Area and may pose an entanglement risk to sea turtles. Potential impacts from decelerators/parachutes as ingestion stressors to sea turtles are discussed in Section 3.8.3.6.2 (Impacts from Military Expended Materials Other Than Munitions).

As described in Section 3.0.3.3.5.2 (Decelerators/Parachutes), decelerators/parachutes used during the proposed activities range in size from 18 in. up to 19–82 ft. in diameter. The vast majority of expended decelerators/parachutes are small (18 in.), cruciform shaped, and used with sonobuoys. Illumination flares use large decelerators/parachutes, up to 19 ft. in diameter. Drones use a larger decelerator/parachute system, ranging from 30 ft. to 82 ft. in diameter. Decelerators/parachutes have short attachment cords and upon impact with water may remain at the surface for 5–15 seconds before sinking to the seafloor, where they flatten. Sonobuoy decelerators/parachutes are designed to sink within 15 minutes, but the rate of sinking depends upon sea conditions and the shape of the decelerator/parachute, and the duration of the descent would depend on the water depth. Unlike the small- and medium-sized decelerators/parachutes, drone decelerators/parachutes do not have weights attached and may remain at the surface or suspended in the water column for some time prior to eventual settlement on the seafloor.

While in the water column, a sea turtle is less likely to become entangled because the decelerator/parachute would have to land directly on the turtle, or the turtle would have to swim into the decelerator/parachute before it sank. Prior to reaching the seafloor, it could be carried along in a current, or snagged on a hard structure near the bottom. Conversely, it could settle to the bottom, where it would be buried by sediment in most soft-bottom areas or colonized by attaching and encrusting organisms, which would further stabilize the material and reduce the potential for reintroduction as an entanglement risk. Decelerators/parachutes or decelerator/parachute lines may be a risk for sea turtles to become entangled, particularly while at the surface. A sea turtle would have to surface to breathe or grab prey from under the decelerator/parachute and swim into the decelerator/parachute or its lines.

If bottom currents are present, the canopy may billow and pose an entanglement threat to sea turtles that feed in benthic habitats (i.e., green, olive ridley, and loggerhead sea turtles). Bottom-feeding sea turtles tend to forage in nearshore areas rather than offshore, where these decelerators/parachutes are used; therefore, sea turtles are not likely to encounter decelerators/parachutes once they reach the seafloor. The potential for a sea turtle to encounter an expended decelerator/parachute at the surface or in the water column is extremely low, and is even less probable at the seafloor, given the general improbability of a sea turtle being near the deployed decelerator/parachute, as well as the general behavior of sea turtles. Depending on how quickly the decelerator/parachute may degrade, the risk may increase with time if the decelerator/parachute remains intact or if underwater currents delay settling of the decelerator/parachute on the seafloor (where they would likely be covered by sediment and encrusted). Factors that may influence degradation times include exposure to ultraviolet radiation and the extent of physical damage of the decelerator/parachute on the water's surface, as well as water temperature and sinking depth. It should be noted that no known instances of sea turtle entanglement with a decelerator/parachute assembly have been reported.

3.8.3.5.2.1 Impacts from Decelerators/Parachutes Under Alternative 1

Impacts from Decelerators/Parachutes Under Alternative 1 for Training Activities

Training activities under Alternative 1 would expend decelerators/parachutes within the Hawaii Range Complex, Southern California Range Complex, and within the Transit Corridor. Based on the numbers and geographic locations of their use, decelerators/parachutes pose a risk of entanglement for all sea turtle species considered in this analysis. Any species of sea turtle that occurs in the Study Area could at some time encounter expended decelerator/parachute. The sink rates of a decelerator/parachute assembly would rule out the possibility of these drifting great distances into nearshore and coastal areas where green, hawksbill, olive ridley, and loggerhead sea turtles are more likely to occur and feed on the bottom. The leatherback is more likely to co-occur with these activities, given its preference for open-ocean habitats, but this species is known to forage on jellyfish at or near the surface. Early juveniles and hatchlings of other sea turtle species (e.g., green sea turtles and loggerheads) may also co-occur with these activities, as well. Under Alternative 1, exposure to decelerators/parachutes used in training activities may cause short-term or long-term disturbance to an individual turtle, because if a sea turtle were to become entangled in a decelerator/parachute, it could free itself, or the entanglement could lead to injury or death. Potential impacts of exposure to decelerator/parachute may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, decelerators are generally not expected to cause disturbance to sea turtles because the decelerator/parachute would have to land directly on an animal, or an animal would have to swim into it before it sinks. Decelerators/parachutes have small footprints which further reduce the potential for entanglement. It is possible, however, that a benthic feeding sea turtle could become entangled when foraging in areas where decelerators/parachutes have settled on the seafloor. For example, if bottom currents are present, the canopy may temporarily billow and pose a greater entanglement threat.

Pursuant to the ESA, the use of decelerators/parachutes during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Decelerators/Parachutes Under Alternative 1 for Testing Activities

Testing activities under Alternative 1 would expend decelerators/parachutes within the Hawaii Range Complex and Southern California Range Complex. Based on the number of decelerators/parachutes expended under Alternative 1 testing activities, the small footprint of impact, and the low likelihood of a decelerator/parachute landing directly on a sea turtle, adverse impacts on sea turtles are discountable (unlikely to occur). While entanglement is a serious stressor for sea turtles from a wide range of debris in the ocean, decelerators/parachutes used during military testing activities are an unlikely source. The leatherback is more likely to co-occur with these activities, given its preference for open-ocean habitats; this species is known to forage on jellyfish at or near the surface. Early juveniles and hatchlings of other sea turtle species (e.g., green sea turtles and loggerheads) may also co-occur with these activities, as well.

Pursuant to the ESA, the use of decelerators/parachutes in testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.5.2.2 Impacts from Decelerators/Parachutes Under Alternative 2

Decelerators/Parachutes Under Alternative 2 for Training Activities

Because training activities under Alternative 2 occur at a similar rate and frequency relative to Alternative 1, entanglement stress experienced by reptiles from decelerators/parachutes under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. Potential impacts from training activities that expend decelerators/parachutes under Alternative 2 would be the same as what was presented in Section 3.8.3.5.2.1 (Impacts from Decelerators/Parachutes Under Alternative 1) for training activities. Therefore, the Navy anticipates that no sea turtles would become entangled in decelerators/parachutes from training activities under Alternative 2.

Pursuant to the ESA, the use of decelerators/parachutes in training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

Impacts from Decelerators/Parachutes Under Alternative 2 for Testing Activities

The locations of testing activities that expend decelerators/parachutes are the same under Alternatives 1 and 2. Even though testing activities under Alternative 2 occur at a slightly higher rate and frequency relative to Alternative 1, entanglement stress experienced by reptiles from decelerators/parachutes under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. These increases are not expected to appreciably increase the risk of entanglement to sea turtles that occur in these areas. Potential impacts from testing activities that expend decelerators/parachutes presented in Section 3.8.3.5.2.1 (Impacts from Decelerators/Parachutes Under

Alternative 1) for testing activities would be applicable to testing activities under Alternative 2. Therefore, the Navy anticipates that no sea turtles would become entangled in decelerators/parachutes.

Pursuant to the ESA, the use of decelerators/parachutes in testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

3.8.3.5.2.3 Impacts from Decelerators/Parachutes Under the No Action Alternative

Impacts from Decelerators/Parachutes Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various entanglement stressors (e.g., decelerators/parachutes) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.5.3 Impacts from Biodegradable Polymer

For a discussion of the types of activities that use biodegradable polymers see Appendix B (Activity Stressor Matrices) and for a discussion on where they are used and how many activities would occur under each alternative, see Section 3.0.3.3.5.3 (Biodegradable Polymer). Navy activities that involve vessel entanglement systems include the development of the biodegradable polymer and would be associated with testing activities in the HSTT Study Area. As indicated by its name, vessel entanglement systems that make use of biodegradable polymers are designed to entangle the propellers of in-water vessels, which would significantly slow and potentially stop the advance of the vessel. A biodegradable polymer is a high molecular weight polymer that degrades to smaller compounds as a result of microorganisms and enzymes The rate of biodegradation could vary from hours to years and the type of small molecules formed during degradation can range from complex to simple products, depending on whether the polymers are natural or synthetic (Karlsson & Albertsson, 1998). 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 hours. This will breakdown 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 sea turtle 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 sea turtle 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. Hatchlings, however, would not likely be able to escape entrapment if they became entangled in a biodegradable polymer if entanglement occurred. Biodegradable polymers would only be a risk to hatchlings while the biodegradable polymer retained its tensile strength. As stated above for larger life stages, this is likely in the timeframe of a few hours after expending, but for hatchlings, a lower tensile strength would be required; therefore, the risk to hatchlings would extend over weeks. Due to the wide dispersion and low numbers of biodegradable polymers as well as the patchy distribution of sea turtles, there is a low likelihood of sea turtles, especially hatchlings, interacting with biodegradable polymers while they are an entanglement risk.

3.8.3.5.3.1 Impacts from Biodegradable Polymer Under Alternative 1

Impacts from Biodegradable Polymer Under Alternative 1 for Training Activities

Biodegradable polymers would not be used during training activities under Alternative 1.

Impacts from Biodegradable Polymer Under Alternative 1 for Testing Activities

Table 3.0-32 shows the numbers of activities that would expend biodegradable polymers and locations where they would be used. Alternative 1 testing activities using biodegradable polymers would occur within the Hawaii Range Complex and Southern California Range Complex. Given the low concentration of biodegradable polymers proposed to be expended within these locations, combined with the limited amount of time each polymer would be intact and considered an entanglement threat, the Navy does not anticipate sea turtles would become entangled with biodegradable polymers.

Pursuant to the ESA, the use of biodegradable polymer during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.5.3.2 Impacts from Biodegradable Polymer Under Alternative 2

Impacts from Biodegradable Polymer Under Alternative 2 for Training Activities

Biodegradable polymers would not be used during training activities under Alternative 2.

Impacts from Biodegradable Polymer Under Alternative 2 for Testing Activities

The location and number of testing activities that expend biodegradable polymers under Alternative 2 would be identical to what is proposed under Alternative 1. The analysis presented in Section 3.8.3.5.3.1 (Impacts from Biodegradable Polymer Under Alternative 1) for testing activities would also apply to Alternative 2.

Pursuant to the ESA, the use of biodegradable polymer during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

3.8.3.5.3.3 Impacts from Biodegradable Polymer Under the No Action Alternative

Impacts from Biodegradable Polymer Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Biodegradable polymer use is not a part of ongoing Navy activities in the Study Area and this entanglement stressor would not be introduced into the marine environment under the No Action Alternative. Therefore no change in baseline conditions of the existing environment would occur.

3.8.3.6 Ingestion Stressors

This section analyzes the potential impacts of the various types of ingestion stressors used during training and testing activities within the Study Area. This analysis includes the potential impacts from the following types of military expended materials: non-explosive practice munitions (small- and medium-caliber), fragments from high-explosives, fragments from targets, chaff, flare casings (including plastic end caps and pistons), decelerators/parachutes, and biodegradable polymers. For a discussion on the types of activities that use these materials refer to Appendix B (Activity Stressor Matrices) and for a discussion on where they are used and how many activities would occur under each alternative, see Section 3.0.3.3.6 (Ingestion Stressors). General discussion of impacts can also be found in Section 3.0.3.6.5 (Conceptual Framework for Assessing Effects from Ingestion). Sea snake species rarely occur in the Study Area, and the very few sea snakes that would travel north from their range would unlikely encounter military expended materials because of their wide distribution within the Study Area. In addition, the yellow-bellied sea snake feeds on fish near the surface and would be unlikely to mistake debris for a prey species. Therefore, sea snake species are not considered further for the analysis of ingestion stressors.

The potential impacts from ingesting these materials is dependent upon the probability of the animal encountering these items in their environment, which is primarily contingent on where the items are expended and how a sea turtle feeds. Sea turtles commonly mistake debris for prey. Recent observations and studies on sea turtle ingestion of non-prey items are summarized in Section 3.8.2.1.5.1 (Water Quality). The risk is prolific throughout sea turtle habitats, and ingestion of expended materials by sea turtles could occur in all large marine ecosystems and open ocean areas and can occur at the surface, in the water column, or at the seafloor, depending on the size and buoyancy of the expended object and the feeding behavior of the turtle. Susceptibility of sea turtles to ingestion risk is a factor of the life-stage of the individual sea turtle, foraging habits of the species, the location of the item within the water column, and the type of debris. For example, floating material could be eaten by turtles such as leatherbacks, juveniles, and hatchlings of all species that feed at or near the water surface, while materials that sink to the seafloor pose a risk to bottom-feeding turtles such as loggerheads. The variety of items eaten by juvenile and hatchling sea turtles of all species and adult leatherbacks that feed are prone to ingesting non-prey items (Fujiwara & Caswell, 2001; Hardesty & Wilcox, 2017; Mitchelmore et al., 2017; Schuyler et al., 2014; Schuyler et al., 2016).

The consequences of ingestion could range from temporary and inconsequential to long-term physical stress or even death. Ingestion of these items may not be directly lethal; however, ingestion of plastic and other fragments can restrict food intake and have sublethal impacts caused by reduced nutrient intake (McCauley & Bjorndal, 1999). Poor nutrient intake can lead to decreased growth rates, depleted energy, reduced reproduction, and decreased survivorship. These long-term sublethal effects may lead to population-level impacts, but this is difficult to assess because the affected individuals remain at sea and the trends may only arise after several generations have passed. Schuyler et al. (2014) determined that most sea turtles at some point will ingest some amount of debris. Because bottom-feeding occurs in nearshore areas, materials that sink to the seafloor in the open ocean are less likely to be ingested due to their location. While these depths may be within the diving capabilities of most sea turtle species, especially leatherback sea turtles, bottom foraging species (i.e., greens, hawksbills, olive ridleys, and loggerheads) are more likely to forage in the shallower waters less than 100 m in depth. This overlaps with only a small portion of the depth range at which military materials are expended.

3.8.3.6.1 Impacts from Military Expended Material- Munitions

Many different types of explosive and non-explosive practice munitions are expended at sea during training and testing activities. Types of non-explosive practice munitions generally include projectiles, missiles, and bombs. Of these, only small- or medium-caliber projectiles would be small enough for a sea turtle to ingest. Small- and medium-caliber projectiles include all sizes up to and including 2.25 in. (57 mm) in diameter. These solid metal materials would quickly move through the water column and settle to the seafloor. Ingestion of non-explosive practice munitions is not expected to occur in the water column because the munitions sink quickly. Instead, they are most likely to be encountered by species that forage on the bottom. Types of high-explosive munitions that can result in fragments include demolition charges, projectiles, missiles, and bombs. Fragments would result from fractures in the munitions casing and would vary in size depending on the size of the net explosive weight and munitions type; however, typical sizes of fragments are unknown. These solid metal materials would quickly move through the water column and settle to the seafloor; therefore, ingestion is not expected by most species. Fragments are primarily encountered by species that forage on the bottom. Other military expended materials such as targets, large-caliber projectiles, intact training and testing bombs, guidance wires, 55-gallon drums, sonobuoy tubes, and marine markers are too large for sea turtles to consume.

Sublethal effects due to ingestion of munitions used in training and activities may cause short-term or long-term disturbance to an individual turtle because: (1) if a sea turtle were to incidentally ingest and swallow a projectile or solid metal high-explosive fragment, it could potentially disrupt its feeding behavior or digestive processes; and (2) if the item is particularly large in proportion to the turtle ingesting it, the item could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle's ability to feed or take in nutrients. Potential impacts of exposure to munitions may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. In open ocean environments, munitions used in training activities are generally not expected to cause disturbance to sea turtles because: (1) sea turtles are not expected to encounter most small- and medium-caliber projectiles or high-explosive fragments on the seafloor because of the depth at which these would be expended; and (2) in some cases, a turtle would likely pass the projectile through their digestive tract and expel the item without impacting the individual. Because green, loggerhead, olive ridley, and hawksbill sea turtles feed along the seafloor, they are more likely to encounter munitions of ingestible size that settle on the bottom than leatherbacks that primarily feed at the surface and in the water column. Furthermore, these four species typically use nearshore feeding areas, while leatherbacks are more likely to feed in the open ocean. Given the very low probability of a leatherback encountering and ingesting materials on the seafloor, this analysis will focus on green, loggerhead, olive ridley, and hawksbill sea turtles and ingestible materials expended in offshore waters

3.8.3.6.1.1 Impacts from Military Expended Materials – Munitions Under Alternative 1

Impacts from Military Expended Materials – Munitions Under Alternative 1 for Training Activities

As indicated in Section 3.0.3.3.6.1 (Non-Explosive Practice Munitions), small- and medium-caliber projectile use would occur throughout the Study Area. Reptiles that occur in these areas would have the potential to be exposed to small- and medium-caliber projectiles. As indicated in Section 3.0.3.3.6.2 (Fragments from High-Explosive Munitions), high-explosive munitions and munitions use may occur throughout the Study Area. When these items explode, they may break apart or remain largely intact in irregularly shaped pieces—some of which may be small enough for some sea turtles or sea snakes to ingest.

In open ocean waters and nearshore habitats, the amount of non-explosive practice munitions and high-explosive munitions fragments that an individual sea turtle would encounter is generally low based on the patchy distribution of both the projectiles and sea turtle feeding habits. In addition, a sea turtle would not likely ingest every projectile it encountered. Furthermore, a sea turtle may attempt to ingest a projectile or fragment and then reject it when it realizes it is not a food item. Therefore, potential impacts of non-explosive practice munitions and fragments ingestion would be limited to the unlikely event in which a sea turtle might suffer a negative response from ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. Sea snakes would have to mistake an item as prey, and would only be exposed in pelagic habitats, but would experience similar impacts as sea turtles. The Navy considers the likelihood of ingestion of military expended materials by sea turtles or sea snakes to be very low.

The Navy will implement mitigation (e.g., not conducting gunnery activities within a specified distance of shallow-water coral reefs and precious coral beds) to avoid potential impacts from military expended materials on seafloor resources in mitigation areas throughout the Study Area (Section 5.4.1, Mitigation Areas for Seafloor Resources). This mitigation will consequently help avoid potential impacts on benthic foraging sea turtles that feed on shallow-water coral reefs and precious coral beds.

Pursuant to the ESA, the use of military expended materials - munitions during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Military Expended Materials – Munitions Under Alternative 1 for Testing Activities

As discussed in Section 3.0.3.3.6 (Ingestion Stressors), use of military expended materials from munitions may occur throughout the HSTT Study Area. Reptiles in the vicinity of these activities would have the potential to ingest military expended materials (small-caliber projectiles and medium-caliber projectiles) from munitions expended during testing activities.

In open ocean waters and nearshore habitats, the amount of non-explosive practice munitions and high-explosive munitions fragments that an individual sea turtle would encounter is generally low based on the patchy distribution of both the projectiles and sea turtle feeding habits. In addition, a sea turtle would not likely ingest every projectile it encountered. Furthermore, a sea turtle may attempt to ingest a projectile or fragment and then reject it when it realizes it is not a food item. Therefore, potential impacts of non-explosive practice munitions and fragments ingestion would be limited to the unlikely event in which a sea turtle might suffer a negative response from ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. The Navy considers the likelihood of this occurring to be very low.

Pursuant to the ESA, the use of military expended materials - munitions during testing activities as described under Alternative 1, would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.6.1.2 Impacts from Military Expended Materials – Munitions Under Alternative 2

Impacts from Military Expended Materials – Munitions Under Alternative 2 for Training Activities

The locations training activities that expend non-explosive practice munitions and high-explosive munition fragments are the same under Alternatives 1 and 2. Even though training activities under Alternative 2 occur at a slightly higher rate and frequency relative to Alternative 1, ingestion stress experienced by reptiles from munitions expended during training events under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. These increases do not substantially increase the risk of ingestion impacts on sea turtles. Therefore, the analysis presented in

Section 3.8.3.6.1.1 (Impacts from Military Expended Materials – Munitions Under Alternative 1) for training activities would also apply to training activities proposed for Alternative 2.

Pursuant to the ESA, the use of military expended materials - munitions during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

Impacts from Military Expended Materials – Munitions Under Alternative 2 for Testing Activities

The locations testing activities that expend non-explosive practice munitions and high-explosive munition fragments are the same under Alternatives 1 and 2. Even though testing activities under Alternative 2 occur at a slightly higher rate and frequency relative to Alternative 1, ingestion stress experienced by reptiles from munitions expended during testing activities under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. These increases do not substantially increase the risk of ingestion impacts on sea turtles. Therefore, the analysis presented in Section 3.8.3.6.1.1 (Impacts from Military Expended Materials – Munitions Under Alternative 1) for training activities would also apply to training activities proposed for Alternative 2.

Pursuant to the ESA, the use of military expended materials - munitions during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

3.8.3.6.1.3 Impacts from Military Expended Materials-Munitions under the No Action Alternative

Impacts from Military Expended Materials- Munitions Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various ingestion stressors (e.g., military expended materials – munitions) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.6.2 Impacts from Military Expended Materials Other Than Munitions

Several different types of materials other than munitions are expended during training and testing activities in the HSTT Study Area. The following military expended materials other than munitions have the potential to be ingested by sea turtles:

- target-related materials
- chaff (including fibers, end caps, and pistons)
- flares (including end caps and pistons)
- decelerators/parachutes (cloth, nylon, and metal weights)
- biodegradable polymer

Target-Related Materials

At-sea targets are usually remotely operated airborne, surface, or subsurface traveling units, most of which are designed to be recovered for reuse. If they are severely damaged or displaced, targets may sink before they can be retrieved. Expendable targets include air-launched decoys, marine markers (smoke floats), cardboard boxes, and 10-ft. diameter red balloons tethered by a sea anchor. Most target fragments would sink quickly in the sea. Floating material, such as Styrofoam, may be lost from target boats and remain at the surface for some time, however during target recovery, personnel would collect as much floating debris and Styrofoam as possible.

Chaff

Chaff is an electronic countermeasure designed to reflect radar waves and obscure aircraft, vessels, and other equipment from radar tracking sources. Chaff is composed of an aluminum alloy coating on glass fibers of silicon dioxide (U.S. Air Force, 1997). It is released or dispensed in cartridges or projectiles that contain millions of chaff fibers. When deployed, a diffuse cloud of fibers undetectable to the human eye is formed. Chaff is a very light material that can remain suspended in air anywhere from 10 minutes to 10 hours and can travel considerable distances from its release point, depending on prevailing atmospheric conditions (Arfsten et al., 2002; U.S. Air Force, 1997). Doppler radar has tracked chaff plumes containing approximately 900 grams (g) of chaff drifting 200 mi. from the point of release, with the plume covering greater than 400 cubic miles (1,667 cubic kilometers) (Arfsten et al., 2002).

The chaff concentrations that sea turtles could be exposed to following release of multiple cartridges (e.g., following a single day of training) are difficult to accurately estimate because it depends on several unknown factors. First, specific release points are not recorded and tend to be random, and chaff dispersion in air depends on prevailing atmospheric conditions. After falling from the air, chaff fibers would be expected to float on the sea surface for some period, depending on wave and wind action. The fibers would be dispersed further by sea currents as they float and slowly sink toward the bottom. Chaff concentrations in benthic habitats following release of a single cartridge would be lower than the values noted in this section, based on dispersion by currents and the enormous dilution capacity of the receiving waters.

Several literature reviews and controlled experiments have indicated that chaff poses little risk, except at concentrations substantially higher than those that could reasonably occur from military training (Arfsten et al., 2002; Spargo, 1999; U.S. Air Force, 1997). Nonetheless, some sea turtle species within the Study Area could be exposed to chaff through direct body contact and ingestion. Chemical alteration of water and sediment from decomposing chaff fibers is not expected to result in exposure. Based on the dispersion characteristics of chaff, it is likely that sea turtles would occasionally come in direct contact with chaff fibers while at the water's surface and while submerged, but such contact would be inconsequential. Chaff is similar to fine human hair (U.S. Air Force, 1997). Because of the flexibility and softness of chaff, external contact would not be expected to impact most wildlife (U.S. Air Force, 1997), and the fibers would quickly wash off shortly after contact. Given the properties of chaff, skin irritation is not expected to be a problem (U.S. Air Force, 1997). Arfsten et al. (2002); Spargo (1999); U.S. Air Force (1997) reviewed the potential effects of chaff inhalation on humans, livestock, and animals and concluded that the fibers are too large to be inhaled into the lung. The fibers are predicted to be deposited in the nose, mouth, or trachea and are either swallowed or expelled; however, these reviews did not specifically consider sea turtles.

Although chaff fibers are too small for sea turtles to confuse with prey and forage, there is some potential for chaff to be incidentally ingested along with other prey items, particularly if the chaff attaches to other floating marine debris. If ingested, chaff is not expected to impact sea turtles due to the low concentration that would be ingested and the small size of the fibers. While no similar studies to those discussed in Section 3.0.3.3.6.3 (Military Expended Materials Other Than Munitions) on the impacts of chaff have been conducted on sea turtles, they are also not likely to be impacted by incidental ingestion of chaff fibers. For instance, some sea turtles ingest spicules (small spines within the structure of a sponge) in the course of eating the sponges, without harm to their digestive system. Since chaff fibers are of similar composition and size as these spicules (Spargo, 1999), ingestion of chaff should be inconsequential for sea turtles.

Chaff cartridge plastic end caps and pistons would also be released into the marine environment, where they would persist for long periods and could be ingested by sea turtles while initially floating on the surface and sinking through the water column. Chaff end caps and pistons would eventually sink in saltwater to the seafloor (Spargo, 2007), which reduces the likelihood of ingestion by sea turtles at the surface or in the water column.

Flares

Flares are designed to burn completely. The only material that would enter the water would be a small, round, plastic compression pad or piston (0.45 to 4.1 g depending on flare type). The flare pads and pistons float in sea water.

An extensive literature review and controlled experiments conducted by the United States Air Force demonstrated that self-protection flare use poses little risk to the environment or animals (U.S. Air Force, 1997). For sea turtles and sea snakes, these types of flares are large enough to not be considered an ingestion hazard. Nonetheless, sea turtles within the vicinity of flares could be exposed to light generated by the flares. It is unlikely that sea turtles or sea snakes would be exposed to any chemicals that produce either flames or smoke since these components are consumed in their entirety during the burning process. Animals are unlikely to approach or get close enough to the flame to be exposed to any chemical components.

Decelerators/Parachutes

As noted previously in Section 3.0.3.3.5.2 (Decelerators/Parachutes), decelerators/parachutes are classified into four different categories based on size: small, medium, large, and extra-large. The majority of expended decelerators/parachutes are in the small category. Decelerators/parachutes in the three remaining size categories (medium – up to 19 ft. in diameter, large – between 30 and 50 ft. in diameter, and extra-large – up to 80 ft.in diameter) are likely too big to be mistaken for prey items and ingested by a sea turtle or sea snake.

The majority of decelerators/parachutes are weighted and by design must sink below the surface within five minutes of contact with the water. Once on the seafloor, decelerators/parachutes become flattened (Environmental Sciences Group, 2005). Ingestion of a decelerator/parachute by a sea turtle or sea snake at the surface or within the water column would be unlikely, since the decelerator/parachute would not be available for very long before it sinks. Once on the seafloor, if bottom currents are present, the canopy may temporarily billow and be available for potential ingestion by a sea turtle feeding on or near the seafloor (sea snakes are not benthic foragers, and therefore would not be exposed to ingestion risk of decelerators/parachutes on the seafloor). Conversely, the decelerator/parachute could be buried by sediment in most soft bottom areas or colonized by attaching and encrusting organisms, which would further stabilize the material and reduce the potential for an ingestion risk. Some decelerators/parachutes may be too large to be a potential prey item for certain age classes (e.g., hatchlings and pre-recruitment juveniles), although degradation of the decelerator/parachute may create smaller items that are potentially ingestible. The majority of these items (from sonobuoys), however, would be expended in deep offshore waters. Bottom-feeding sea turtles (e.g., green, hawksbill, olive ridley, and loggerhead turtles) tend to forage in nearshore and coastal areas rather than offshore, where the majority of these decelerators/parachutes are used. Since these materials would most likely be expended in offshore waters too deep for benthic foraging, it would be unlikely for bottom-foraging sea turtles to interact with these materials once they sink; therefore, it is unlikely that sea turtles would encounter decelerators/parachutes once they reach the seafloor.

Biodegradable Polymer

As stated in Section 3.0.3.3.5.3 (Biodegradable Polymer) based on the constituents of the biodegradable polymer, it is anticipated that the material will breakdown into small pieces within a few days to weeks. The small pieces will breakdown further and dissolve into the water column within weeks to a few months and could potentially be incidentally ingested by sea turtles. Because the final products of the breakdown are all environmentally benign, the Navy does not expect the use biodegradable polymer to be an ingestion stressor for sea turtles; therefore, is not analyzed further.

3.8.3.6.2.1 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

As presented in Section 3.0.3.3.6 (Ingestion Stressors), military expended materials other than munitions would be expended during offshore training activities within the Hawaii Range Complex and Southern California Range Complex.

Target-related material, chaff, flares, decelerators/parachutes (and their subcomponents), and biodegradable polymers have the potential to be ingested by a sea turtle, although that is considered unlikely since most of these materials would quickly drop through the water column, settle on the seafloor, or rapidly decay, and not present an ingestion hazard. Some Styrofoam, plastic endcaps, chaff, and other small items may float for some time before sinking.

While the smaller items discussed here may pose a hazard to sea turtles, as discussed for non-explosive practice munitions ingestion, the impacts of ingesting these forms of expended materials on sea turtles would be minor because of the following factors:

- the limited geographic area where materials other than munitions are expended during a given event
- the limited period of time these military expended materials would remain in the water column
- the unlikely chance that a sea turtle might encounter and swallow these items on the seafloor, particularly given that many of these items would be expended over deep, offshore waters

The impacts of ingesting military expended materials other than munitions would be limited to cases where an individual sea turtle might eat an indigestible item too large to be passed through the gut. The sea turtle would not be preferentially attracted to these military expended materials, with the possible exception of decelerators/parachutes that may appear similar to the prey of some sea turtle species and life stages that feed on jellyfish and similar organisms. For the most part, these military expended materials would most likely only be incidentally ingested by individuals feeding on the bottom in the precise location where these items were deposited. Non-munition military expended materials that would remain floating on the surface are too small to pose a risk of intestinal blockage to any sea turtle that happened to encounter it. Because leatherbacks and juveniles of some species (e.g., green sea turtles) are more likely to feed at or near the surface, they are more likely to encounter materials at the surface than are other species of turtles that primarily feed along the seafloor. Furthermore, leatherbacks typically feed in the open ocean, while other species are more likely to feed in nearshore areas. Though they are bottom-feeding species that generally feed nearshore, green, hawksbill, olive ridley, and loggerhead sea turtles may occur in the open ocean during migrations, as well as hatchling and juvenile stage turtles.

Sublethal impacts due to ingestion of military expended materials other than munitions used in training activities may cause short-term or long-term disturbance to an individual turtle because (1) if a sea turtle were to incidentally ingest and swallow a decelerator/parachute, target fragment, chaff or flare component, it could potentially disrupt its feeding behavior or digestive processes; and (2) if the item is particularly large in proportion to the turtle ingesting it, the item could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle's ability to feed or take in nutrients. Potential impacts of exposure to these items may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, decelerators/parachutes, target fragments, chaff, and flare components used in training activities are generally not expected to cause disturbance to sea turtles because (1) leatherbacks are likely to forage further offshore than within range complexes, and other sea turtles primarily forage on the bottom in nearshore areas; (2) in some cases, a turtle would likely pass the item through its digestive tract and expel the item without impacting the individual; and (3) chaff, if ingested, would occur in very low concentration and is similar to spicules, which sea turtles (species and life stages that consume sponges and other organisms containing spicules) ingest without harm. Potential impacts of exposure to military expended materials other than munitions are not expected to result in population-level impacts.

Pursuant to the ESA, the use of military expended materials other than munitions during training activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

Impacts from Military Expended Materials Other Than Munitions Under Alternative 1 for Testing Activities

As presented in Section 3.0.3.3.6 (Ingestion Stressors) military expended materials other than munitions would be expended during testing activities within the Hawaii Range Complex and Southern California Range Complex. Target-related material, chaff, flares, decelerators/parachutes (and their subcomponents), and biodegradable polymers have the potential to be ingested by a sea turtle, although that is considered unlikely since most of these materials would quickly drop through the water column, settle on the seafloor, or in the case of biodegradable polymers, rapidly decay and not present an ingestion hazard. Some Styrofoam, plastic endcaps, chaff, and other small items may float for some time before sinking.

While the smaller items discussed here may pose a hazard to sea turtles, as discussed for non-explosive practice munitions ingestion, the impacts of ingesting these forms of expended materials on sea turtles would be minor because of the following factors:

- the limited geographic area where materials other than munitions are expended during a given event
- the limited period of time these military expended materials would remain in the water column
- the unlikely chance that a sea turtle might encounter and swallow these items on the seafloor, particularly given that many of these items would be expended over deep, offshore waters

The impacts of ingesting military expended materials other than munitions would be limited to cases where an individual sea turtle might eat an indigestible item too large to be passed through the gut. The sea turtle would not be preferentially attracted to these military expended materials, with the possible exception of decelerators/parachutes that may appear similar to the prey of some sea turtle species and life stages that feed on jellyfish and similar organisms. For the most part, these military expended materials would most likely only be incidentally ingested by individuals feeding on the bottom in the precise location where these items were deposited. Non-munition military expended materials that would remain floating on the surface are too small to pose a risk of intestinal blockage to any sea turtle that happened to encounter it. Because leatherbacks and juveniles of some species (e.g., green sea turtles) are more likely to feed at or near the surface, they are more likely to encounter materials at the surface than are other species of turtles that primarily feed along the seafloor. Furthermore, leatherbacks typically feed in the open ocean, while other species are more likely to feed in nearshore areas. Though they are bottom-feeding species that generally feed nearshore, green, hawksbill, olive ridley, and loggerhead sea turtles may occur in the open ocean during migrations, as well as hatchling and juvenile stage turtles.

Pursuant to the ESA, the use of military expended materials other than munitions during testing activities as described under Alternative 1 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.6.2.2 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

As presented in Section 3.0.3.3.6 (Ingestion Stressors), the locations of training activities that expend military expended materials other than munitions would be identical under Alternatives 1 and 2. Even though training activities under Alternative 2 occur at a slightly higher rate and frequency relative to Alternative 1, ingestion stress experienced by reptiles from expended materials other than munitions during training events under Alternative 2 are not expected to be meaningfully different than those described under Alternative 1. The fractional increase in amount of military expended materials other than munitions would not substantially increase the potential for sea turtles to ingest these items. Therefore the analysis presented in Section 3.8.3.6.2.1 (Impacts from Military Expended Materials Other Than Munitions Under Alternative 1) for training activities would also apply to training activities proposed under Alternative 2.

Pursuant to the ESA, the use of military expended materials other than munitions during training activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

Impacts from Military Expended Materials Other Than Munitions Under Alternative 2 for Testing Activities

As presented in Section 3.0.3.3.6 (Ingestion Stressors) the locations of testing activities that expend military expended materials other than munitions would be identical under Alternatives 1 and 2. The number of military expended materials other than munitions used in these locations during testing activities would be the same under Alternative 2 as under Alternative 1. Therefore the analysis presented in Section 3.8.3.6.2.1 (Impacts from Military Expended Materials Other Than Munitions Under Alternative 1) for testing activities would also apply to testing activities proposed under Alternative 2.

Pursuant to the ESA, the use of military expended materials other than munitions during testing activities as described under Alternative 2 would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles.

3.8.3.6.2.3 Impacts from Military Expended Materials Other Than Munitions Under the No Action Alternative

Impacts from Military Expended Materials Other Than Munitions Under the No Action Alternative for Training and Testing Activities

Under the No Action Alternative, the Navy would not conduct the proposed training and testing activities in the HSTT Study Area. Various ingestion stressors (e.g., military expended materials other than munitions) would not be introduced into the marine environment. Therefore, baseline conditions of the existing environment would either remain unchanged or would improve slightly after cessation of ongoing training and testing activities.

3.8.3.7 Secondary Stressors

This section analyzes potential impacts on sea turtles and sea snakes exposed to stressors indirectly through impacts on their habitat (sediment or water quality) or prey availability. For the purposes of this analysis, indirect impacts on reptiles via sediment or water quality that do not require trophic transfer (e.g., bioaccumulation) in order to be observed are considered here. Bioaccumulation considered previously in this document in the analysis of fish (Section 3.6), invertebrates (Section 3.4), and marine habitats (Section 3.5) indicated minimal to no impacts on potential prey species of sea turtles and sea snakes. It is important to note that the terms “indirect” and “secondary” do not imply reduced severity of environmental consequences but instead describe how the impact may occur in an organism. The potential for impacts from all of these secondary stressors are discussed below.

Stressors from Navy training and testing activities that could pose indirect impacts on sea turtles and sea snakes via habitat or prey include: (1) explosives, (2) explosive byproducts and unexploded munitions, (3) metals, and (4) chemicals. Analyses of the potential impacts on sediment and water quality are discussed in Section 3.2 (Sediments and Water Quality).

Explosives

Underwater explosions could impact other species in the food web, including sea turtle and sea snake prey species, and could disrupt ecological relationships and conditions that would lead to decreased availability of forage. The impacts of explosions would differ depending on the type of prey species in the area of the blast. As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.6-1 through Table 2.6-5, training and testing activities resulting in underwater explosions will occur in the Study Area.

In addition to the physical effects of an underwater blast (e.g., injury or mortality from the blast pressure wave), prey might have behavioral reactions to underwater sound. For instance, prey might exhibit a strong startle reaction to detonations that might include swimming to the surface or scattering away from the source. This startle and flight response is the most common secondary defense among animals (Mather, 2004). The abundance of prey near the detonation point could be diminished for a short period before being repopulated by animals from adjacent waters (Berglind et al., 2009; Craig, 2001). Many sea turtle prey items, such as jellyfish, sponges, and molluscs, have limited mobility and ability to react to pressure waves; therefore, mobile prey species for sea turtles and sea snakes would be less affected because of their ability to respond to other stressors preceding an underwater blast (e.g., vessel noise or visual cues). Any of these scenarios would be temporary, only occurring during activities involving explosives, and no lasting effect on prey availability or the pelagic food web would be expected. For example, if prey were removed from an area resulting from a stressor introduced by a training or testing activity, prey species would be expected to return to or recolonize rapidly in the area because there would be little or no permanent change to the habitat.

The Navy will implement mitigation (e.g., not conducting gunnery activities within a specified distance of shallow-water coral reefs) to avoid potential impacts from explosives and physical disturbance and strike stressors on seafloor resources in mitigation areas throughout the Study Area (see Section 5.4.1, Mitigation Areas for Seafloor Resources). This mitigation will consequently help avoid potential impacts from explosives on sea turtle and sea snake prey species that inhabit shallow-water coral reefs, live hard bottom, precious coral beds, artificial reefs, and shipwrecks.

Explosion Byproducts and Unexploded Munitions

High-order explosions consume most of the explosive material, creating typical combustion products. In the case of Royal Demolition Explosive, also known as cyclonite and hexogen, 98 percent of the byproducts are common seawater constituents, and the remainder is rapidly diluted below threshold effect level (Section 3.2, Sediments and Water Quality). Explosion byproducts associated with high-order detonations present no indirect stressors to sea turtles or sea snakes through sediment or water. Furthermore, most explosions occur in depths exceeding those which normally support seagrass beds and coral reefs, areas that are commonly used by green and hawksbill sea turtles. For example, most detonations would occur in waters greater than 200 ft. in depth, and greater than 3 NM from shore, although mine warfare, demolition, and some testing detonations would occur in shallow water close to shore. These low-order detonations and unexploded munitions present elevated likelihood of secondary impacts on sea turtles. For sea snakes, deep diving to these depths is not likely, and they would not be exposed to indirect stressors from explosion byproducts or unexploded munitions.

Deposition of undetonated explosive materials into the marine environment can be reasonably well estimated by the known failure and low-order detonation rates of high explosives (Section 3.2, Sediments and Water Quality, Table 3.2-10). While it is remotely possible for sea turtles to come into contact with an undetonated explosive, to have contact with unexploded materials in the sediment or water, and or to ingest unexploded materials in sediments, it is very unlikely. For sea snakes, benthic foraging in pelagic environments is unlikely to occur, and interactions with undetonated explosives is highly unlikely.

Indirect impacts by explosives and unexploded munitions to sea turtles via sediment contamination would only be possible only if a sea turtle ingested the sediment. Degradation of explosives proceeds through several pathways, as discussed in Section 3.2.3.1 (Explosives and Explosives Byproducts). Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen & Lotufo, 2010). Relatively low solubility of most explosives and their degradation products means that concentrations of these contaminants in the marine environment are relatively low and readily diluted. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately 6–12 in. away from degrading munitions, the concentrations of these compounds were not statistically distinguishable from background beyond 3–6 ft. from the degrading munitions (Section 3.2.3.1, Explosives and Explosives Byproducts). Taken together, it is possible that sea turtles could be exposed to degrading explosives, but it would be within a very small radius of the explosive (1 to 6 ft.). Sea snakes, with shallow water pelagic habits, would not likely interact with sediments.

A series of research efforts focused on World War II underwater munitions disposal sites in Hawaii (Edwards et al., 2016; Kelley et al., 2016; Koide et al., 2016; University of Hawaii, 2010) and an intensively used live fire range in the Mariana Islands (Smith & Marx, 2016) provide information in regard to the impacts of undetonated materials and unexploded munitions on marine life. Section 3.2.3.1 (Explosives and Explosives Byproducts) and Section 3.2.3.3 (Metals) contains a summary of this literature that investigated water and sediment quality impacts, on a localized scale, from munitions ocean disposal sites and ocean disposed dredge spoils sites. Findings from these studies indicate that there were no adverse impacts on the local ecology from the presence of degrading munitions and there was no bioaccumulation of munitions-related chemicals in local marine species.

The island of Farallon De Medinilla (in the Mariana Islands) has been used as a target area since 1971. Between 1997 and 2012, there were 14 underwater scientific survey investigations around the island providing a long-term look at potential impacts on the marine life from training and testing involving the use of munitions (Smith & Marx, 2016). Munitions use has included high-explosive rounds from gunfire, high-explosives bombs by Navy aircraft and U.S. Air Force B-52s, in addition to the expenditure of inert rounds and non-explosive practice bombs. Marine life assessed during these surveys included algae, corals, benthic invertebrates, sharks, rays, and bony fishes, and sea turtles. The investigators found no evidence over the 16-year period that the condition of the biological resources had been adversely impacted to a significant degree by the training activities (Smith & Marx, 2016). Furthermore, they found that the health, abundance, and biomass of fishes, corals and other marine resources were comparable to or superior to those in similar habitats at other locations within the Mariana Archipelago.

These findings are consistent with other assessments such as that done for the Potomac River Test Range at Dahlgren, Virginia, which was established in 1918 and is the nation's largest fully instrumented, over-the-water gun-firing range. Munitions tested at Naval Surface Warfare Center, Dahlgren have included rounds from small-caliber guns up to the Navy's largest (16 in. guns), bombs, rockets, mortars, grenades, mines, depth charges, and torpedoes (U.S. Department of the Navy, 2013b). Results from the assessment indicate that munitions expended at Naval Surface Warfare Center, Dahlgren have not contributed to significant concentrations of metals to the Potomac River water and sediments, given those contributions are orders of magnitude lower than concentrations already present in the Potomac River from natural and manmade sources (U.S. Department of the Navy, 2013b).

The concentration of munitions/explosions, expended material, or devices in any one location in the HSTT Study Area would be a small fraction of that from a World War II dump site, or a target island used for 45 years, or a water range in a river used for almost 100 years. Based on findings from much more intensively used locations, the water quality effects from the use of munitions, expended material, or devices resulting from any of the proposed actions would be negligible by comparison. As a result, explosion by-products and unexploded munitions would have no meaningful effect on water quality and would therefore not constitute a secondary indirect stressor for sea turtles or sea snakes.

Metals

Metals are introduced into seawater and sediments as a result of training and testing activities involving ship hulks, targets, munitions, and other military expended materials (see Section 3.2.3.2, Metals) (Environmental Sciences Group, 2005). Some metals bioaccumulate and physiological impacts begin to occur only after several trophic transfers concentrate the toxic metals (Section 3.5, Habitats; and Chapter 4, Cumulative Impacts). Evidence from a number of studies (Briggs et al., 2016; Edwards et al., 2016; Kelley et al., 2016; Koide et al., 2016) indicate metal contamination is very localized and that bioaccumulation resulting from munitions cannot be demonstrated. Specifically in sampled marine life living on or around munitions on the seafloor, metal concentrations could not be definitively linked to the munitions since comparison of metals in sediment next to munitions show relatively little difference in comparison to other "clean" marine sediments used as a control/reference (Koide et al., 2015). Research has demonstrated that some smaller marine organisms are attracted to metal munitions as a hard substrate for colonization or as shelter (Kelley et al., 2015; Smith and Marx, 2016). Although this would likely increase prey availability for some benthic foraging sea turtles that feed on molluscs (e.g., loggerheads), the relatively low density of metals deposited by training and testing activities compared to concentrated dump and range sites would not likely substantively benefit sea turtles. As stated above, pelagic habits and shallow water diving would not likely present any opportunities for sea snake interactions with metal contaminated sediments.

Chemicals

Several Navy training and testing activities introduce chemicals into the marine environment that are potentially harmful in higher concentrations; however, rapid dilution would occur, and toxic concentrations are unlikely to be encountered. Chemicals introduced are principally from flares and propellants for missiles and torpedoes. Properly functioning flares, missiles, and torpedoes combust most of their propellants, leaving benign or readily diluted soluble combustion byproducts (e.g., hydrogen cyanide). Operational failures may allow propellants and their degradation products to be released into the marine environment. Flares and missile that operationally fail may release perchlorate, which is highly soluble in water, persistent, and impacts metabolic processes in many plants and animals if in sufficient concentration. Such concentrations are not likely to persist in the ocean. Research has demonstrated that perchlorate did not bioconcentrate or bioaccumulate, which was consistent with the expectations for a water-soluble compound (Furin et al., 2013). Perchlorate from failed expendable items is therefore unlikely to compromise water quality to that point that it would act as a secondary stressor to sea turtles. It should also be noted that chemicals in the marine environment as a result of Navy training and testing activities would not occur in isolation and are typically associated with military expended materials that release the chemicals while in operation. Because sea turtles and sea snakes would likely avoid expended flares, missiles, or torpedoes in the water (because of other cues such as visual and noise disturbance), avoidance would further reduce the potential for introduced chemicals to act as a secondary stressor.

3.8.3.7.1 Impacts on Habitat

As presented above in Section 3.8.3.7 (Secondary Stressors), Navy activities that introduce explosive byproducts and unexploded munitions, metals, and chemicals into the marine environment have not demonstrated long-term impacts on sediment and water quality. Explosive byproducts and unexploded munitions from ongoing Navy activities have not resulted in water quality impacts, and the likelihood of sea turtles or sea snakes being in contact with sediments contaminated from degrading explosives is low, given the small radius of impact around the location of the explosive. Furthermore, there is no evidence of bioconcentration or bioaccumulation of chemicals introduced by Navy activities that would alter water quality to an extent that would result in overall habitat degradation for sea turtles or sea snakes.

As stated previously, most detonations would occur in waters greater than 200 ft. in depth, and greater than 3 NM from shore, although mine warfare, demolition, and some testing detonations would occur in shallow water close to shore. In deep waters, explosions would not likely impact habitat for sea turtles or sea snakes because the explosion would not be on or proximate to the sea floor. In nearshore waters, explosions would typically occur in the same locations, limiting the removal of habitat to previously disturbed areas. Therefore, habitat loss from training and testing activities that use explosions would not substantially remove habitats available to sea turtles and sea snakes and not impact sea turtle or sea snake individuals or populations.

Pursuant to the ESA, training and testing activities that introduce secondary stressors would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed green, hawksbill, olive ridley, loggerhead, and leatherback sea turtles through minor and localized indirect impacts on these species' habitat. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.3.7.2 Impacts on Prey Availability

As presented above in Section 3.8.3.7 (Secondary Stressors), Navy activities that introduce explosives, metals, and chemicals into the marine environment have not demonstrated long-term impacts on prey availability for sea turtles or sea snakes. Bioaccumulation of metals from munitions in prey species has not been demonstrated, and no effects to prey availability from metals and chemicals are known to occur.

Training and testing activities in the HSTT Study Area would be unlikely to impact coral reefs (a direct and indirect source of prey and forage items for sea turtles) because the Navy implements mitigation for shallow-water coral reefs. These mitigation measures would continue under both Alternative 1 and Alternative 2.

Pursuant to the ESA, training and testing activities that introduce secondary stressors would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect ESA-listed sea turtles through minor and localized indirect impacts on these species' prey availability. The Navy has consulted with NMFS as required by section 7(a)(2) of the ESA.

3.8.4 Summary of Potential Impacts on Reptiles

3.8.4.1 Combined Impacts of All Stressors Under Alternative 1

As described in Section 3.0.3.5 (Resource-Specific Impacts Analysis for Multiple Stressors), this section evaluates the potential for combined impacts of all the stressors from the proposed action. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in Sections 3.8.3.1 (Acoustic Stressors) through 3.8.3.6 (Ingestion Stressors) and, for ESA-listed species, summarized in Section 3.8.5 (Endangered Species Act Determinations). Stressors associated with Navy training and testing 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 that the majority of exposures to stressors are non-lethal, and instead focuses on consequences potentially impacting sea turtle or sea snake fitness (e.g., physiology, behavior, reproductive potential).

Additive Stressors–There are generally two ways that a sea turtle or sea snake could be exposed to multiple additive stressors. The first would be if an animal were exposed to multiple sources of stress from a single event or activity (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, aircraft) that may produce one or more stressors; therefore, it is likely that if a sea turtle or sea snake 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 cause a response. However, due to the wide dispersion of stressors, speed of the platforms, general dynamic movement of many training and testing activities, and behavioral avoidance exhibited by sea turtles, it is very unlikely that a sea turtle or sea snake would remain in the potential impact range of multiple sources or sequential exercises. Exposure to multiple stressors is more likely to occur at an instrumented range where training and testing 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 training and small testing activities which are conducted in the open ocean. Unit level exercises occur over a small spatial scale (one to a few square miles) and with few participants (usually one or two vessels) or short duration (the order of a few hours or less).

Secondly, a sea turtle or sea snake could be exposed to multiple training and testing activities over the course of its life, however, training and testing activities are generally separated in space and time in such a way that it would be unlikely that any individual sea turtle or sea snake would be exposed to stressors from multiple activities within a short timeframe. However, sea turtles with a home range intersecting an area of concentrated Navy activity have elevated exposure risks relative to sea turtles that simply transit the area through a migratory corridor. Sea snakes in open ocean environments within the Study Area are more associated with currents without home ranges in pelagic areas; therefore, activities concentrated in repeated geographic locations would not present a risk to pelagic roaming sea snakes. This limited potential for exposure of individuals is not anticipated to impact populations.

Synergistic Stressors–Multiple stressors may also have synergistic effects on sea turtles. Assumed to rarely occur in the Study Area, and not occurring within groups, sea snakes would likely not experience synergistic effects. Sea turtles that react to a sound source (behavioral response) or experience injury from acoustic stressors could be more susceptible to physical strike and disturbance stressors via a decreased ability to detect and avoid threats. Sea turtles that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to entanglement and physical strike stressors via malnourishment and disorientation. Similarly, sea turtles that may be weakened by disease (e.g., fibropapillomatosis) or other factors that are not associated with Navy training and testing activities may be more susceptible to stressors analyzed in this EIS. These interactions are speculative, and without data on the combination of multiple Navy stressors, the synergistic impacts from the combination of Navy stressors are difficult to predict in any meaningful way. 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 (National Oceanic and Atmospheric Administration, 2013; National Oceanic and Atmospheric Administration, 2015) are that majority of impacts from Navy training and testing activities are not expected to have deleterious impacts on the fitness of any individuals or long-term consequences to populations of sea turtles.

Although potential impacts on certain sea turtle species from training and testing activities under Alternative 1 may include injury to individuals, those injuries are not expected to lead to consequences for populations. The potential impacts anticipated from Alternative 1 are summarized in Sections 3.8.4.4 (Endangered Species Act Determinations). For a discussion of cumulative impacts, see Chapter 4 (Cumulative Impacts).

3.8.4.2 Combined Impacts of All Stressors Under Alternative 2

Under Alternative 2, the potential for exposure of sea turtles or sea snakes to multiple stressors would increase relative to Alternative 1, thereby increasing the risk of synergistic effects on sea turtles or sea snakes and possibly increasing the exposure of sea turtles or sea snakes to different stressors throughout a reptile's life. The impacts would be similar as described under Alternative 1, such as reducing the reptile's ability to respond to a stressor while coping with the effects of another stressor. As with Alternative 1, however, activities are separated by geographic location and time, which reduces the potential for synergistic effects of multiple exposures to different stressors and repeated exposures over time. The combined impacts of all stressors for training and testing activities under Alternative 2 are not expected to have deleterious impacts on the fitness of any individuals or long-term consequences to populations.

3.8.4.3 Combined Impacts of All Stressors under the No Action Alternative

Under the No Action Alternative, training and testing activities associated with the Proposed Action will not be conducted within the HSTT Study Area. Under this alternative, there would be no potential for impacts on sea turtles or sea snakes. The cessation of some stressors would be more beneficial than others. For instance, because of the localized and short-term duration of any potential impact from an electromagnetic field on a sea turtle, the potential benefits to sea turtles or sea snakes are not likely measureable. The removal of fast vessel movement training activities, however, would likely decrease behavioral impacts and responses to vessels, but again, the impact is likely short-term, with normal behaviors resuming within minutes of a passing vessel. Vessel strike risk would be reduced, which would likely increase survivability and individual fitness for a small number of sea turtles or sea snakes. Further, the synergistic effects of multiple stressors would not occur, thereby providing benefits to sea turtles and sea snakes by removing short-term and long-term potential impacts. The implementation of the No Action Alternative would remove risks of impacts associated with training and testing activities; however, monitoring data accumulated through range sustainment programs would cease. These data provide foundational data for the research and regulatory communities to assess ongoing threats and conservation status of various species.

3.8.5 Endangered Species Act Determinations

Administration of ESA obligations associated with sea turtles are shared between NMFS and USFWS, depending on life stage and specific location of the sea turtle. NMFS has jurisdiction over sea turtles in the marine environment, and USFWS has jurisdiction over sea turtles on land.

Pursuant to the ESA, the Navy has consulted with NMFS on Alternative 1 (the Preferred Alternative) as required by section 7(a)(2) of the ESA and determined that training and testing would have no effect on leatherback sea turtle critical habitat because activities would not occur within the designated critical habitat for this species, but may affect the green sea turtle, hawksbill sea turtle, olive ridley sea turtle, loggerhead sea turtle, and leatherback sea turtle.

The Navy also consulted with the USFWS for the potential impacts of amphibious landing activities on sea turtle nesting areas at PMRF. The USFWS concurred with the Navy's determination that amphibious landing activities at PMRF may affect but is not likely to adversely affect the green, hawksbill, and olive ridley sea turtles. Copies of agency correspondence are found in Appendix J (Agency Correspondence).

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