Atlantic Fleet Training and Testing Final Environmental Impact Statement / Overseas Environmental Impact Statement

Volume 2
August 2013

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Department of the Navy

Cooperating Agency
National Marine Fisheries Service

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3.4 Marine Mammals

MARINE MAMMALS SYNOPSIS

The Navy considered all potential stressors and analyzed the following for marine mammals:

- Acoustic (sonar and other active acoustic sources; explosives; pile driving; swimmer defense airguns; weapons firing, launch, and impact noise; vessel noise; aircraft noise)
- Energy (electromagnetic devices and high energy lasers)
- Physical disturbance and strike (vessels; in-water devices; military expended materials; seafloor devices)
- Entanglement (fiber optic cables and guidance wires; parachutes)
- Ingestion (munitions and military expended materials other than munitions)
- Secondary (explosives and byproducts, metals, chemicals, and transmission of disease and parasites)

Preferred Alternative (Alternative 2)

- Acoustic: Pursuant to the Marine Mammal Protection Act (MMPA), the use of sonar and other active acoustic sources may result in Level A or Level B harassment of certain marine mammals; the use of explosives may result in mortality, Level A or Level B harassment of certain marine mammals; pile driving is not expected to result in mortality but may result in Level A or Level B harassment of bottlenose dolphins; the use of swimmer defense airguns, weapons firing, vessel noise, and aircraft noise are not expected to result in mortality, Level A or Level B harassment of any marine mammals. Pursuant to the Endangered Species Act (ESA), sonar and other active acoustic sources and explosives may affect and are likely to adversely affect certain ESA-listed marine mammals; pile driving, swimmer defense airguns, weapons firing, vessel noise, and aircraft noise may affect but are not likely to adversely affect certain ESA-listed marine mammals; and all acoustic sources will have no effect on marine mammal critical habitats.

- Energy: Pursuant to the MMPA, the use of electromagnetic devices and high energy lasers is not expected to result in mortality, Level A or Level B harassment of any marine mammals. Pursuant to the ESA, the use of electromagnetic devices may affect but are not likely to adversely affect certain ESA-listed marine mammals and will have no effect on marine mammal critical habitats. Pursuant to the ESA, the use of high energy lasers will have no effect on any ESA-listed marine mammal and will have no effect on marine mammal critical habitats.

- Physical Disturbance and Strike: Pursuant to the MMPA, the use of vessels may result in mortality or Level A harassment of certain marine mammal species but is not expected to result in Level B harassment of any marine mammal. The use of in-water devices, military expended materials, and seafloor devices are not expected to result in mortality, Level A or Level B harassment of any marine mammal. Pursuant to the ESA, vessel use may affect and is likely to adversely affect certain ESA-listed species. The use of in-water devices and military expended materials may affect but is not likely to adversely affect certain marine mammal species. The use of seafloor devices will have no effect on any ESA-listed marine mammal. The use of vessels, in-water devices, military expended materials, and seafloor devices will have no effect on marine mammal critical habitats.

- Entanglement: Pursuant to the MMPA, the use of fiber optic cables, guidance wires, and parachutes is not expected to result in mortality, Level A or Level B harassment of any marine mammal. Pursuant to the ESA, the use of fiber optic cables, guidance wires, and parachutes may affect but is not likely to adversely affect certain ESA-listed marine mammals.

- Ingestion: Pursuant to the MMPA, the potential for ingestion of all military expended materials is not expected to result in mortality, Level A or Level B harassment of any marine mammal. Pursuant to the ESA, the potential for ingestion of all military expended materials may affect but is not likely to adversely affect certain ESA-listed species.

- Secondary: Pursuant to the MMPA, secondary stressors are not expected to result in mortality, Level A or Level B harassment of any marine mammal. Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect certain ESA-listed marine mammals and will have no effect on marine mammal critical habitats.

The use of sonar and active acoustic sources are not expected to result in mortality, although the potential for beaked whale mortality coincident with use of sonar and other active acoustic sources is considered. The Navy has requested 10 beaked whale mortality takes under the MMPA as part of all training activities combined to account for any unforeseen potential impacts.

3.4.1 INTRODUCTION AND METHODS

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 or, in freshwater environments, such as manatees and certain freshwater dolphins (Jefferson et al. 2008b; 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 classification, see the formal list *Marine Mammal Species and Subspecies* maintained by the Society for Marine Mammalogy.

All marine mammals in the United States are protected under the Marine Mammal Protection Act (MMPA), and some species receive additional protection under the Endangered Species Act (ESA). Section 3.0.1 (Regulatory Framework) discusses the regulatory framework. Within the framework of the MMPA, a marine mammal "stock" is defined as "a group of marine mammals of the same species or smaller taxon (subspecies) in a common spatial arrangement that interbreed when mature" (16 United States Code [U.S.C.] § 1362). For management under the MMPA, a stock is considered an isolated population or group of individuals within a whole species that is found in the same area. However, in practice, recognized management stocks may fall short of this ideal because of a lack of information or other reasons and in some cases may even include multiple species, as with certain beaked whales (Carretta et al. 2010).

There are 48 marine mammal species known to exist in the Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area). Among these species are 93 stocks managed by the National Marine Fisheries Service (NMFS) or the United States (U.S.) Fish and Wildlife Service in the U.S. Exclusive Economic Zone. These species and stocks are presented in Table 3.4-1, and relevant information on their status, distribution, abundance, and ecology is presented in Section 3.4.2 (Affected Environment). Some material contained in this chapter was summarized from the book *Marine Mammals of the World: A Comprehensive Guide to Their Identification* (Jefferson et al. 2008b). In addition, portions of text for individual species were excerpted directly from 2010 and 2012 U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments (Waring et al. 2010). Table 3.0-2 relates Navy activity areas to the appropriate large marine ecosystem, open ocean area, bay, sound, or estuary.

For summaries of the general biology and ecology of marine mammals beyond the scope of this section, see Rice (1998), Reynolds and Rommel (1999), Twiss and Reeves (1999), Hoelzel (2002), Berta et al. (2006), Jefferson et al. (2008b), and Perrin et al. (2008b). Additional species profiles and information on the biology, life history, species distribution and conservation of marine mammals can also be found on the following websites:

- National Marine Fisheries Service Office of Protected Resources (includes species distribution maps)
- Ocean Biogeographic Information System-Spatial Ecological Analysis of Megavertebrate Populations species profiles
- International Whaling Commission
- International Union for Conservation of Nature, Cetacean Specialist Group
- The Marine Mammal Commission
- Society for Marine Mammalogy

Table 3.4-1: Marine Mammal Occurrence within the Atlantic Fleet Training and Testing Study Area

Common Name	Scientific Name[1]	ESA/MMPA Status[2]	Stock[3]	Stock Abundance[3] Best (CV) / Min	Occurrence in Study Area[4]		
					Open Ocean	Large Marine Ecosystems	Bays, Rivers, and Estuaries
Order Cetacea							
Suborder Mysticeti (baleen whales)							
Family Balaenidae (right whales)							
North Atlantic Right Whale	*Eubalaena glacialis*	Endangered, Strategic, Depleted	Western North Atlantic	444 (0) / 444	Gulf Stream, Labrador Current	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Bowhead Whale	*Balaena mysticetus*	Endangered, Strategic, Depleted	West Greenland	1,230[5] / 490–2,940	Labrador Current	Newfoundland-Labrador Shelf, West Greenland Shelf	–
Family Balaenopteridae (rorquals)							
Humpback Whale	*Megaptera novaeangliae*	Endangered, Strategic, Depleted	Gulf of Maine	823 (0) / 823	Gulf Stream, North Atlantic Gyre, Labrador Current	Gulf of Mexico, Caribbean Sea, Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Minke Whale	*Balaenoptera acutorostrata*		Canadian east coast	20,741 (0.30) / 16,199	Gulf Stream, North Atlantic Gyre, Labrador Current	Caribbean Sea, Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Bryde's Whale	*Balaenoptera brydei/edeni*		Gulf of Mexico Oceanic	33 (1.07) / 16	Gulf Stream, North Atlantic Gyre	Gulf of Mexico, Caribbean Sea, Southeast U.S. Continental Shelf	–
Sei Whale	*Balaenoptera borealis*	Endangered, Strategic, Depleted	Nova Scotia	357 (0.52) / 236	Gulf Stream, North Atlantic Gyre, Labrador Current	Gulf of Mexico, Caribbean Sea, Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Fin Whale	*Balaenoptera physalus*	Endangered, Strategic, Depleted	Western North Atlantic	3,522 (0.27) / 2718	Gulf Stream, North Atlantic Gyre, Labrador Current	Caribbean Sea, Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Blue Whale	*Balaenoptera musculus*	Endangered, Strategic, Depleted	Western North Atlantic	NA / 440[6]	Gulf Stream, North Atlantic Gyre, Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Suborder Odontoceti (toothed whales)							
Family Physeteridae (sperm whale)							
Sperm Whale	*Physeter macrocephalus*	Endangered, Strategic, Depleted	North Atlantic	1,593 (0.56) / 1,187	Gulf Stream, North Atlantic Gyre, Labrador Current	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
		Endangered, Strategic, Depleted	Gulf of Mexico Oceanic	763 (0.38) / 560	–	Gulf of Mexico	–
		Endangered, Strategic, Depleted	Puerto Rico and U.S. Virgin Islands	unknown	North Atlantic Gyre	Caribbean Sea	–
Family Kogiidae (sperm whales)							
Pygmy Sperm Whale	*Kogia breviceps*	Strategic	Western North Atlantic	741 (0.) / 535	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
			Gulf of Mexico Oceanic	186(1.04) / 90[7]	–	Gulf of Mexico, Caribbean Sea	–
Dwarf Sperm Whale	*Kogia sima*		Western North Atlantic	1042 (0.65) / 632	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf	–
			Gulf of Mexico Oceanic	186(1.04) / 90[7]	–	Gulf of Mexico, Caribbean Sea	–

1 Taxonomy follows Perrin 2009.
2 ESA listing status. All marine mammals are protected under MMPA. Populations or stocks for which the level of direct human-caused mortality exceeds the potential biological removal level, which, based on the best available scientific information, are declining and are likely to be listed as a threatened species under the ESA within the foreseeable future, or is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA are considered "strategic" under MMPA.
3 Coefficient of variation (CV) is a statistic measurement used as an indicator of the accuracy of the estimate. Stock designations for the U.S. Exclusive Economic Zone and abundance estimates from 2012 Stock Assessment Reports (Waring et al. 2010).
4 Occurrence in the Study Area includes open ocean areas—Labrador Current, North Atlantic Gyre, Gulf Stream, and coastal/shelf waters of seven Large Marine Ecosystems— West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico, and inland waters of Kennebec River, Piscataqua River, Thames River, Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Sandy Hook Bay, Lower Chesapeake Bay, James River, Elizabeth River, Beaufort Inlet, Cape Fear River, Kings Bay, St. Johns River, Port Canaveral, St. Andrew Bay, Pascagoula River, Sabine Lake, Corpus Christi Bay, and Galveston Bay (Table 3.0-2 and Figure 3.0-1 in Section 3.0.3, Ecological Characterization of the Study Area).
5 The bowhead whale population off the west coast of Greenland is not managed by NMFS and therefore does not have an associated Stock Assessment Report. Abundance and 95 percent confidence interval are provided by the International Whaling Commission.
6 Photo identification catalogue count of 440 recognizable blue whale individuals from the Gulf of St. Lawrence is considered a minimum population estimate for the western North Atlantic stock.
7 Estimate may include both the pygmy and dwarf sperm whales

Table 3.4-1: Marine Mammal Occurrence within the Atlantic Fleet Training and Testing Study Area (Continued)

Common Name	Scientific Name[1]	ESA/MMPA Status[2]	Stock[3]	Stock Abundance[3] Best (CV) / Min	Occurrence in Study Area[4]		
					Open Ocean	Large Marine Ecosystems	Bays, Rivers, and Estuaries
Family Monodontidae (beluga whale and narwhal)							
Beluga Whale	*Delphinapterus leucas*		NA[8]	NA[8]		Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Narwhal	*Monodon monoceros*		NA[9]	NA[9]		Newfoundland-Labrador Shelf, West Greenland Shelf	–
Family Ziphiidae (beaked whales)							
Cuvier's Beaked Whale	*Ziphius cavirostris*		Western North Atlantic	4,962 (0.37) / 3,670	Gulf Stream, North Atlantic Gyre, Labrador Current	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
			Gulf of Mexico Oceanic	74 (1.04) / 36		Gulf of Mexico, Caribbean Sea	–
			Puerto Rico and U.S. Virgin Islands	Unknown	–	Caribbean Sea	
True's Beaked Whale	*Mesoplodon mirus*		Western North Atlantic	Unknown	Gulf Stream, North Atlantic Gyre, Labrador Current	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Gervais' Beaked Whale	*Mesoplodon europaeus*		Western North Atlantic	1,847 (0.96) / 935	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast United States Continental Shelf	–
			Gulf of Mexico Oceanic	149 (.91) / 77[11]	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	–
Sowerby's Beaked whale	*Mesoplodon bidens*		Western North Atlantic	3,653 (0.69) / 2,160[10]	Gulf Stream, North Atlantic Gyre	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Blainville's Beaked Whale	*Mesoplodon densirostris*		Western North Atlantic	Unknown	Gulf Stream, North Atlantic Gyre, Labrador Current	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
			Gulf of Mexico Oceanic	149 (.91) / 77[11]	–	Gulf of Mexico, Caribbean Sea	–
Northern Bottlenose Whale	*Hyperoodon ampullatus*		Western North Atlantic	Unknown	Gulf Stream, North Atlantic Gyre, Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Family Delphinidae (dolphins)							
Rough-Toothed Dolphin	*Steno bredanensis*		Western North Atlantic	Unknown	Gulf Stream, North Atlantic Gyre	Caribbean Sea, Southeast U.S. Continental Shelf	–
			Gulf of Mexico (Outer continental shelf and Oceanic)	624 (0.99) / 311	–	Gulf of Mexico, Caribbean Sea	–
Bottlenose Dolphin	*Tursiops truncatus*	Strategic, Depleted	Western North Atlantic, offshore[12]	81,588 (0.17) / 70,775	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	–
		Strategic, Depleted	Western North Atlantic, coastal, northern migratory	9,604 (0.36) / 7,147	–	Southeast U.S. Continental Shelf	Island Sound, Sandy Hook Bay, Lower Chesapeake Bay, James River, Elizabeth River
		Strategic, Depleted	Western North Atlantic, coastal, southern migratory	12,482 (0.32) / 9,591	–	Southeast U.S. Continental Shelf	Lower Chesapeake Bay, James River, Elizabeth River, Beaufort Inlet, Cape Fear River, Kings Bay, St. Johns River
		Strategic, Depleted	Western North Atlantic, coastal, South Carolina/ Georgia	7,738 (0.23) / 6,399	–	Southeast U.S. Continental Shelf	Kings Bay, St. Johns River
		Strategic, Depleted	Western North Atlantic, coastal, Northern Florida	3,064 (0.24) / 2,511	–	Southeast U.S. Continental Shelf	Kings Bay, St. Johns River

1 Taxonomy follows Perrin 2009.
2 ESA listing status. All marine mammals are protected under MMPA. Populations or stocks for which the level of direct human-caused mortality exceeds the potential biological removal level, which, based on the best available scientific information, are declining and are likely to be listed as a threatened species under the ESA within the foreseeable future, or is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA are considered "strategic" under MMPA.
3 Coefficient of variation (CV) is a statistic measurement used as an indicator of the accuracy of the estimate. Stock designations for the U.S. Exclusive Economic Zone and abundance estimates from 2012 Stock Assessment Reports (Waring et al. 2010).
4 Occurrence in the Study Area includes open ocean areas—Labrador Current, North Atlantic Gyre, Gulf Stream, and coastal/shelf waters of seven Large Marine Ecosystems— West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico, and inland waters of Kennebec River, Piscataqua River, Thames River, Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Sandy Hook Bay, Lower Chesapeake Bay, James River, Elizabeth River, Beaufort Inlet, Cape Fear River, Kings Bay, St. Johns River, Port Canaveral, St. Andrew Bay, Pascagoula River, Sabine Lake, Corpus Christi Bay, and Galveston Bay (Table 3.0-2 and Figure 3.0-1 in Section 3.0.3, Ecological Characterization of the Study Area).
8 Beluga whales in the Atlantic are not managed by NMFS and have no associated Stock Assessment Report.
9 Narwhals in the Atlantic are not managed by NMFS and have no associated Stock Assessment Report.
10 Estimate includes Cuvier's beaked whales and undifferentiated *Mesoplodon* species.
11 Estimate includes Gervais' and Blainville's beaked whales
12 Estimate may include sightings of the coastal form.

Table 3.4-1: Marine Mammal Occurrence within the Atlantic Fleet Training and Testing Study Area (Continued)

Common Name	Scientific Name[1]	ESA/MMPA Status[2]	Stock[3]	Stock Abundance[3] Best (CV) / Min	Occurrence in Study Area[4]		
					Open Ocean	Large Marine Ecosystems	Bays, Rivers, and Estuaries
		Strategic	Western North Atlantic, coastal, Central Florida	6,318 (0.26) / 5,094	–	Southeast U.S. Continental Shelf	Port Canaveral
		Strategic	Northern North Carolina Estuarine System	950 (0.23) / 785	–	Southeast U.S. Continental Shelf	Beaufort Inlet, Cape Fear River
		Strategic	Southern North Carolina Estuarine System	2,454 (0.53) / 1,614	–	Southeast U.S. Continental Shelf	Beaufort Inlet, Cape Fear River
		Strategic	Charleston Estuarine System	Unknown	–	Southeast U.S. Continental Shelf	–
		Strategic	Northern Georgia/ Southern South Carolina Estuarine System	Unknown	–	Southeast U.S. Continental Shelf	–
		Strategic	Southern Georgia Estuarine System	Unknown	–	Southeast U.S. Continental Shelf	Kings Bay, St. Johns River
		Strategic	Jacksonville Estuarine System	Unknown	–	Southeast U.S. Continental Shelf	Kings Bay, St. Johns River
		Strategic	Indian River Lagoon Estuarine System	Unknown	–	Southeast U.S. Continental Shelf	Port Canaveral
		Strategic	Biscayne Bay	Unknown	–	Southeast U.S. Continental Shelf	–
			Florida Bay	514 (0.17) / 447	–	Gulf of Mexico	–
			Gulf of Mexico Continental Shelf	Unknown	–	Gulf of Mexico	–
			Gulf of Mexico, eastern coastal	7,702 (0.19) / 6,551	–	Gulf of Mexico	–
			Gulf of Mexico, northern coastal	2,473 (0.25) / 2,004	–	Gulf of Mexico	St. Andrew Bay, Pascagoula River
		Strategic	Gulf of Mexico, western coastal	Unknown	–	Gulf of Mexico	Corpus Christi Bay, Galveston Bay
			Gulf of Mexico Oceanic	5,806 (0.39) / 4,230	–	Gulf of Mexico	–
		Strategic	Gulf of Mexico bay, sound, and estuarine (29 stocks)	Unknown	–	Gulf of Mexico	St. Andrew Bay, Pascagoula River, Sabine Lake, Corpus Christi Bay, and Galveston Bay
			Barataria Bay	Unknown	–	Gulf of Mexico	–
			St. Joseph Bay	146 (0.18) / 126	–	Gulf of Mexico	–
			Choctawhatchee Bay	179 (0.04) / 173	–	Gulf of Mexico	–
			Puerto Rico and U.S. Virgin Islands	Unknown	–	Caribbean Sea	–
Pantropical Spotted Dolphin	*Stenella attenuata*		Western North Atlantic	4,439 (0.49) / 3,010	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	–
			Gulf of Mexico Oceanic	50,880 (0.27) / 40,699	–	Gulf of Mexico, Caribbean Sea	–
Atlantic Spotted Dolphin	*Stenella frontalis*		Western North Atlantic	26,798 (0.66) / 16,151	Gulf Stream	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
			Gulf of Mexico (Continental shelf and Oceanic)	Unknown	–	Gulf of Mexico, Caribbean Sea	–
Spinner Dolphin	*Stenella longirostris*		Western North Atlantic	Unknown	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf	–
			Gulf of Mexico Oceanic	11,441 (0.83) / 6,221	–	Gulf of Mexico, Caribbean Sea	–
			Puerto Rico and U.S. Virgin Islands	Unknown	–	Caribbean Sea	–

1 Taxonomy follows Perrin 2009.
2 ESA listing status. All marine mammals are protected under MMPA. Populations or stocks for which the level of direct human-caused mortality exceeds the potential biological removal level, which, based on the best available scientific information, are declining and are likely to be listed as a threatened species under the ESA within the foreseeable future, or is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA are considered “strategic” under MMPA.
3 Coefficient of variation (CV) is a statistic measurement used as an indicator of the accuracy of the estimate. Stock designations for the U.S. Exclusive Economic Zone and abundance estimates from 2012 Stock Assessment Reports (Waring et al. 2010).
4 Occurrence in the Study Area includes open ocean areas—Labrador Current, North Atlantic Gyre, Gulf Stream, and coastal/shelf waters of seven Large Marine Ecosystems— West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico, and inland waters of Kennebec River, Piscataqua River, Thames River, Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Sandy Hook Bay, Lower Chesapeake Bay, James River, Elizabeth River, Beaufort Inlet, Cape Fear River, Kings Bay, St. Johns River, Port Canaveral, St. Andrew Bay, Pascagoula River, Sabine Lake, Corpus Christi Bay, and Galveston Bay Table 3.0-2 and Figure 3.0-1 in Section 3.0.3, Ecological Characterization of the Study Area).

Table 3.4-1: Marine Mammal Occurrence within the Atlantic Fleet Training and Testing Study Area (Continued)

Common Name	Scientific Name[1]	ESA/MMPA Status[2]	Stock[3]	Stock Abundance[3] Best (CV) / Min	Occurrence in Study Area[4]		
					Open Ocean	Large Marine Ecosystems	Bays, Rivers, and Estuaries
Clymene Dolphin	*Stenella clymene*		Western North Atlantic	Unknown	Gulf Stream	Southeast U.S. Continental Shelf	–
			Gulf of Mexico Oceanic	129 (1.0) / 64	–	Gulf of Mexico, Caribbean Sea	–
Striped Dolphin	*Stenella coeruleoalba*		Western North Atlantic	46,882 (0.33) / 35,763	Gulf Stream	-	–
			Gulf of Mexico Oceanic	1,849 (0.77) / 1,041	–	Gulf of Mexico, Caribbean Sea	–
Fraser's Dolphin	*Lagenodelphis hosei*		Western North Atlantic	Unknown	North Atlantic Gyre	Southeast U.S. Continental Shelf	–
			Gulf of Mexico Oceanic	Unknown	–	Gulf of Mexico, Caribbean Sea	–
Risso's Dolphin	*Grampus griseus*		Western North Atlantic	20,479 (0.59) / 12,920	Gulf Stream	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
			Gulf of Mexico Oceanic	2,442 (0.57) / 1,563	–	Gulf of Mexico, Caribbean Sea	–
Atlantic White-Sided Dolphin	*Lagenorhynchus acutus*		Western North Atlantic	23,390 (0.23) / 19,019	Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
White-Beaked Dolphin	*Lagenorhynchus albirostris*		Western North Atlantic	2,003 (0.94) / 1,023	Labrador Current	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Long-Beaked Common Dolphin	*Delphinus capensis*		NA[13]	Unknown[13]	–	Caribbean Sea[13]	–
Short-Beaked Common Dolphin	*Delphinus delphis*		Western North Atlantic	67,191 (0.29) / 52,893	Gulf Stream	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Melon-Headed Whale	*Peponocephala electra*		Western North Atlantic	Unknown	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf	–
			Gulf of Mexico Oceanic	2,235 (0.75) / 1,274	–	Gulf of Mexico, Caribbean Sea	–
Pygmy Killer Whale	*Feresa attenuata*		Western North Atlantic	Unknown	Gulf Stream, North Atlantic Gyre	Southeast U.S. Continental Shelf	–
			Gulf of Mexico Oceanic	152 (1.02) / 75	–	Gulf of Mexico, Caribbean Sea, Southeast U.S. Continental Shelf	–
False Killer Whale	*Pseudorca crassidens*		Gulf of Mexico Oceanic	Unknown	Gulf Stream, North Atlantic Gyre	Gulf of Mexico, Caribbean Sea, Southeast U.S. Continental Shelf	–
Killer Whale	*Orcinus orca*		Western North Atlantic	Unknown	Gulf Stream, North Atlantic Gyre, Labrador Current	Southeast U.S. Continental Shelf, Northeast U.S. Continental shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
			Gulf of Mexico Oceanic	28 (1.02) / 14	–	Gulf of Mexico, Caribbean Sea	–
Long-Finned Pilot Whale	*Globicephala melas*		Western North Atlantic	12,619 (0.37) / 9,333	Gulf Stream	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Short-Finned Pilot Whale	*Globicephala macrorhynchus*		Western North Atlantic	24,674 (0.45) / 17,190	Gulf Stream	Northeast Continental Shelf, Southeast U.S. Continental Shelf	–
			Gulf of Mexico Oceanic	2,415 (0.66) / 1456	–	Gulf of Mexico, Caribbean Sea	–
			Puerto Rico and U.S. Virgin Islands	Unknown	–	Caribbean Sea	–
Family Phocoenidae (porpoises)							
Harbor Porpoise	*Phocoena phocoena*		Gulf of Maine/Bay of Fundy	89,054 (0.47) / 60,970	–	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Piscataqua River, Thames River, Kennebec River

[1] Taxonomy follows Perrin 2009.
[2] ESA listing status. All marine mammals are protected under MMPA. Populations or stocks for which the level of direct human-caused mortality exceeds the potential biological removal level, which, based on the best available scientific information, are declining and are likely to be listed as a threatened species under the ESA within the foreseeable future, or is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA are considered "strategic" under MMPA.
[3] Coefficient of variation (CV) is a statistic measurement used as an indicator of the accuracy of the estimate. Stock designations for the U.S. Exclusive Economic Zone and abundance estimates from 2012 Stock Assessment Reports (Waring et al. 2010).
[4] Occurrence in the Study Area includes open ocean areas—Labrador Current, North Atlantic Gyre, Gulf Stream, and coastal/shelf waters of seven Large Marine Ecosystems— West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico, and inland waters of Kennebec River, Piscataqua River, Thames River, Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Sandy Hook Bay, Lower Chesapeake Bay, James River, Elizabeth River, Beaufort Inlet, Cape Fear River, Kings Bay, St. Johns River, Port Canaveral, St. Andrew Bay, Pascagoula River, Sabine Lake, Corpus Christi Bay, and Galveston Bay (Table 3.0-2 and Figure 3.0-1 in Section 3.0.3, Ecological Characterization of the Study Area).
[13] Long-beaked common dolphins are only known in the western Atlantic from a discrete population off the east coast of South America.
[14] Polar bears are managed by the U.S. Fish and Wildlife Service but do not occur in the Atlantic U.S. Exclusive Economic Zone and therefore have no associated Stock Assessment Reports.

Table 3.4-1: Marine Mammal Occurrence within the Atlantic Fleet Training and Testing Study Area (Continued)

Common Name	Scientific Name[1]	ESA/MMPA Status[2]	Stock[3]	Stock Abundance[3] Best (CV) / Min	Occurrence in Study Area[4]		
					Open Ocean	Large Marine Ecosystems	Bays, Rivers, and Estuaries
Order Carnivora							
Family Ursidae (bears)							
Polar Bear	*Ursus maritimus*	Threatened	NA[14]	Unknown	–	Newfoundland-Labrador Shelf, West Greenland Shelf	–
Suborder Pinnipedia							
Family Phocidae (true seals)							
Ringed Seal	*Pusa hispida*	Threatened	NA[15]	Unknown	–	Newfoundland-Labrador Shelf, West Greenland Shelf	–
Bearded Seal	*Erignathus barbatus*		NA[15]	Unknown	–	Scotian Shelf, Newfoundland-Labrador Shelf, West Greenland Shelf	
Hooded Seal	*Cystophora cristata*		Western North Atlantic	Unknown	–	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf, West Greenland Shelf	Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Piscataqua River, Thames River, Kennebec River
Harp Seal	*Pagophilus groenlandicus*		Western North Atlantic	Unknown	–	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	–
Gray Seal	*Halichoerus grypus*		Western North Atlantic	Unknown	–	Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Piscataqua River, Thames River, Kennebeck River
Harbor Seal	*Phoca vitulina*		Western North Atlantic	Unknown	–	Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, Scotian Shelf, Newfoundland-Labrador Shelf	Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Piscataqua River, Thames River, Kennebeck River
Family Odobenidae (walrus)							
Walrus	*Odobenus rosmarus*		NA[16]	NA[16]	–	Newfoundland-Labrador Shelf, West Greenland Shelf	–
Order Sirenia							
Family Trichechidae (manatees)							
West Indian Manatee	*Trichechus manatus*[17]	Endangered, Strategic	Florida, Antillean	4,840[18]	–	Gulf of Mexico, Southeast U.S. Continental Shelf, Caribbean	Cape Fear River, Bogue Sound, St. Johns River, Kings Bay, Port Canaveral, Pascagoula River, St. Andrew Bay, Corpus Christi Bay, Sabine Lake, and Galveston Bay

[1] Taxonomy follows Perrin 2009.

[2] ESA listing status. All marine mammals are protected under MMPA. Populations or stocks for which the level of direct human-caused mortality exceeds the potential biological removal level, which, based on the best available scientific information, are declining and are likely to be listed as a threatened species under the ESA within the foreseeable future, or is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA are considered "strategic" under MMPA.

[3] Coefficient of variation (CV) is a statistic measurement used as an indicator of the accuracy of the estimate. Stock designations for the U.S. Exclusive Economic Zone and abundance estimates from 2012 Stock Assessment Reports (Waring et al. 2010).

[4] Occurrence in the Study Area includes open ocean areas—Labrador Current, North Atlantic Gyre, Gulf Stream, and coastal/shelf waters of seven Large Marine Ecosystems— West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, Gulf of Mexico, and inland waters of Kennebec River, Piscataqua River, Thames River, Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, Long Island Sound, Sandy Hook Bay, Lower Chesapeake Bay, James River, Elizabeth River, Beaufort Inlet, Cape Fear River, Kings Bay, St. Johns River, Port Canaveral, St. Andrew Bay, Pascagoula River, Sabine Lake, Corpus Christi Bay, and Galveston Bay (Table 3.0-2 and Figure 3.0-1 in Section 3.0.3, Ecological Characterization of the Study Area).

[15] These species do not occur within the Atlantic U.S. Exclusive Economic Zone and therefore are not managed by NMFS and have no associated Stock Assessment Reports. See the appropriate subsections below for details of populations that may be found within the Study Area.

[16] Walruses are managed by the U.S. Fish and Wildlife Services in the Atlantic U.S. Exclusive Economic Zone and therefore have no associated Stock Assessment Report. The North Atlantic Marine Mammal Commission identifies eight putative stocks in the Atlantic ranging from under 500 to 6,000 individuals each, although they note that the quality ratings of these estimates are only fair to poor.

[17] The West Indian manatee is divided into the Florida (*Trichechus manatus latirostris*) and Antillean (*Trichechus manatus manatus*) subspecies

[18] The West Indian manatee is managed by the U.S. Fish and Wildlife Service. Actual count is based on a single synoptic survey of warm-water refuges in January 2011 (Florida Fish and Wildlife Conservation Commission 2011)

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3.4.2 Affected Environment

Four main types of marine mammals are generally recognized: cetaceans (whales, dolphins, and porpoises), pinnipeds (seals, sea lions, and walruses), sirenians (manatees, dugongs, and sea cows), and other marine carnivores (sea otters, marine otters, and polar bears) (Jefferson et al. 2008b; Rice 1998). The order Cetacea is divided into two suborders – Odontoceti and Mysticeti. The toothed whales, dolphins, and porpoises (suborder Odontoceti) range in size from slightly longer than 3.3 ft. (1 m) to more than 60 ft. (18 m) and have teeth, which they use to capture and consume individual prey. The baleen whales (suborder Mysticeti) are universally large (more than 15 ft. [5 m] as adults). They are called baleen whales because, instead of teeth, they have a fibrous structure made of keratin, a type of protein like that found in human fingernails, in their mouths, which enables them to filter or extract food from the water for feeding. They are batch feeders that use this baleen instead of teeth to engulf, suck, or skim large numbers of prey, such as small schooling fish, shrimp, or microscopic sea animals (i.e., plankton) from the water or out of ocean floor sediments (Heithaus and Dill 2008). The baleen whales are further divided into two families—right whales and rorquals. Rorquals have a series of longitudinal folds of skin, often referred to as throat grooves, running from below the mouth back toward the navel. Rorquals are slender and streamlined in shape, compared with their relatives the right whales, and most have narrow, elongated flippers. Detailed reviews of the different groups of cetaceans can be found in Perrin et al. (2009).

Most pinnipeds can be divided into two families: phocids (true seals) and the otariids (fur seals and sea lions). Another family of pinnipeds contains a single species, the walrus, which in many ways is an intermediate between the true seals and sea lions (Berta et al. 2006). The order Sirenia (sirenians) includes one species of manatee found in the Study Area, the West Indian manatee (*Trichechus manatus*), a slow-moving plant-eater that inhabits shallow coastal and inland waters. Finally, the polar bear is a marine carnivore that is usually classified as a marine mammal found in the Study Area.

Cetaceans inhabit virtually every marine environment in the Study Area. Marine mammals in the Study Area occur from coastal and inland waters to the open Atlantic Ocean. Their distribution is influenced by many factors, primarily patterns of major ocean currents, which in turn affect prey productivity. The continuous movement of water from the ocean bottom to the surface creates a nutrient-rich, highly productive environment for marine mammal prey (Jefferson et al. 2008b). For most cetaceans, prey distribution, abundance, and quality largely determine where they occur at any specific time (Heithaus and Dill 2008). Most of the baleen whales are migratory, but many of the toothed whales do not migrate in the strictest sense. Instead, they undergo seasonal dispersal or shifts in density. Pinnipeds occur mostly in coastal habitats or within those regions over the continental shelf, while manatees, otters, and polar bears are the most coastal groups of marine mammals. All require land or shallow coastal waters as habitat for reproducing, resting, and, in some cases, feeding.

3.4.2.1 Group Size

Many species of marine mammals, particularly odontocetes (toothed whales), are highly social animals that spend much of their lives living in groups or pods ranging from several to several thousand individuals. Similarly, aggregations of baleen whales may form during particular breeding or foraging seasons, although they do not persist through time as a social unit. Group or podding behavior in marine mammals is important because it enhances an observer’s ability to detect them for mitigation and monitoring. Group size characteristics were also incorporated into the acoustic effects modeling to represent a more realistic patchy distribution for the given density. A comprehensive and systematic review of relevant literature and data was conducted for available published and unpublished literature including journals, books, technical reports, survey cruise reports, raw data from cruises, theses, and dissertations. The results of this review were compiled into a technical report (Watwood and Buonantony 2012), including tables of group size information by species along with relevant citations.

3.4.2.2 Diving

Some species of marine mammals have developed specialized adaptations to allow them to make deep dives lasting over an hour, primarily for 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 an observer’s ability to detect them for mitigation and monitoring. In addition, their relative distribution through the water column is an important consideration when conducting acoustic exposure analyses. Information and data on diving behavior for each species of marine mammal was compiled and summarized in a technical report (Watwood and Buonantony 2012) that provides the detailed summary of time at depth used for distributing animals through the water column within the acoustic exposure model.

3.4.2.3 Vocalization and Hearing of Marine Mammals

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

Marine mammal hearing abilities are quantified using live animals by either behavioral audiometry or electrophysiology. Behavioral audiograms, which are plots of animals’ exhibited hearing threshold versus frequency, are obtained from captive, trained live animals using standard testing procedures with appropriate controls and are considered to be a more accurate representation of a subject's hearing abilities. Behavioral audiograms of marine mammals are difficult to obtain because many species are too large, too rare, and too difficult to acquire and maintain. Consequently, our understanding of a species’ hearing ability may be based on the behavioral audiogram of a single individual or small group of animals. In addition, captive animals may be exposed to local ambient sounds and other environmental factors that could affect their hearing abilities and may not accurately reflect the hearing abilities of free-swimming animals. For animals not available in captive or stranded settings (including large whales and rare species) estimates of hearing capabilities are made based on physiological structures, vocal characteristics, and extrapolations from related species.

In comparison, electrophysiological audiometry measures small electrical voltages produced by neural activity when the auditory system is stimulated by sound. The technique is relatively fast, does not require a conscious response, and is routinely used to assess the hearing of newborn humans. Hearing response in relation to frequency for both methods of evaluating hearing ability is depicted as a U-shaped curve showing the frequency range of best sensitivity (lowest hearing threshold) and frequencies above and below with higher threshold values.

Direct measurements of hearing sensitivity exist for approximately 25 of the nearly 130 species of marine mammals. Table 3.4-2 summarizes sound production and 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, mid-frequency cetaceans, low-frequency cetaceans (mysticetes), phocid pinnipeds (true seals), odobenid pinnipeds (walrus), polar bears, mustelids (sea otters), and sirenians (manatees). Note that frequency ranges for high-, mid-, and low-frequency cetacean hearing differ from the frequency ranges

Table 3.4-2: Hearing and Vocalization Ranges for All Marine Mammal Functional Hearing Groups and Species Potentially Occurring within the Study Area

Functional Hearing Group (FHG)	Species which may be present in the Study Area	FHG Sound Production[1]		FHG Hearing Ability Frequency Range[1]
		Frequency Range	Source Level (dB re 1 µPa at 1 m)	
High-Frequency Cetaceans	Harbor porpoise, *Kogia* species (dwarf and pygmy sperm whales)	100 Hz to 200 kHz [e,m,q]	120 to 205	200 Hz to 180 kHz [d,v]
Mid-Frequency Cetaceans	Sperm whale, Blainville's beaked whale, True's beaked whale, Gervais' beaked whale, Cuvier's beaked whale, northern bottlenose whale, Sowerby's beaked whale, bottlenose dolphin, Clymene dolphin, short-beaked common dolphin, long-beaked common dolphin, Fraser's dolphin, killer whale, false killer whale, pygmy killer whale, melon-headed whale, short-finned pilot whale, long-finned pilot whale, Risso's dolphin, rough-toothed dolphin, spinner dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, striped dolphin, white-beaked dolphin, Atlantic white-sided dolphin, narwhal, beluga whale	100 Hz to >100 kHz [e,h,j,l,m]	118 to 236	150 Hz to 160 kHz [v]
Low-Frequency Cetaceans	Bowhead whale, North Atlantic right whale, blue whale, Bryde's whale, fin whale, humpback whale, minke whale, sei whale	10 Hz to 20 kHz [a,m,r]	129 to 195	7 Hz to 22 kHz[v]
Phocidae	Ringed seal, bearded seal, hooded seal, gray seal, harbor seal, harp seal	100 Hz to 12 kHz [b,m,n,o]	103 to 180	In-water: 75 Hz to 75 kHz In-air: 75 Hz to 30 kHz [t,u,v]
Otariidae and Odobenidae	Walrus	30 Hz to 10 kHz [c,m,o,p]	120 - 196	In-water: 50 Hz to 50 kHz In-air: 50 Hz to 75 kHz [t,u,v]
Mustelidae	None present	Primarily 4 kHz to 8 kHz [f,l,k,m]	In-air: up to 113	In-water: unknown In-air: 125 Hz to 35 kHz; peak sensitivity at 16 kHz [s,v]
Sirenians	West Indian manatee	500 Hz to 16 kHz [g,m]	91 to 150	75 Hz to 75 kHz [v]
Polar Bear	Polar bear	–	–	In-water: 50 Hz to 50 kHz In-air: 50 Hz to 35 kHz [v]

[1]Sound production levels and ranges and functional hearing ranges are generalized composites for all members of the functional hearing groups, regardless of their presence in this Study Area.

Sound production data adapted and derived from: [a]Aburto, et al. 1997; [b]Hanggi & Schusterman, 1994; [c]Hughes et al. 2011; [d]Kastelein et al., 2002; [e]Marten 2000; [f]McShane et al. 1995; [g]Miksis-Olds & Tyack 2009; [h]Møhl et al. 2003; [i]O'Shea & Poché Jr. 2006; [j]Philips et al. 2003; [k]Phillips et al. 2004; [l]Rasmussen et al. 2006; [m]Richardson et al. 1995; [n]Rossong & Terhune 2009; [o]Schusterman et al. 1970; [p]Verboom & Kastelein 1995; [q]Villadsgaard et al. 2007; [r]Würsig et al. 1980.

Hearing data adapted and derived from: [s]Ghoul & Reichmuth 2012; [t]Hemila et al. 2006; [d]Kastelein et al. 2002; [u]Schusterman1981; [v]Southall et al. 2007

These frequency ranges and source levels include social sounds for all groups and echolocation sounds for mid- and high-frequency groups. In-air vocalizations were not included for pinniped groups. Vocalization parameters for Mustelidae were measured from in-air vocalizations; no underwater data are available for this group. Energy and harmonics are present in their calls above 10 kHz to 60 kHz although the behavioral functionality is unknown.

dB re 1 µPa @ 1 m: decibels (dB) referenced to (re) 1 micro (µ) Pascal (Pa) at 1 meter; Hz: Hertz; kHz: kilohertz defined in similar terms to describe active sonar systems. For discussion of all marine mammal functional hearing groups and their derivation see Finneran and Jenkins (2012).

3.4.2.3.1 High-Frequency Cetaceans

Marine mammals within the high-frequency cetacean functional hearing group are all odontocetes (toothed whales, suborder Odontoceti) and include eight species and subspecies of porpoises (family Phocoenidae), dwarf and pygmy sperm whales (family Kogiidae), six species and subspecies of river dolphins, and four species of *Cephalorynchus*. Only the following members of the high-frequency cetacean group are present in the Study Area: harbor porpoise, dwarf sperm whale, and pygmy sperm whale. Functional hearing in high-frequency cetaceans occurs between approximately 200 Hertz (Hz) and 180 kilohertz (kHz)(Southall et al. 2007).

Sounds produced by high-frequency cetaceans range from approximately 100 Hz to 200 kHz with source levels of 120 to 205 dB referenced to (re) 1 micro (µ) Pascal (Pa) at 1 meter (m) (Madsen et al. 2005; Richardson et al. 1995; Verboom and Kastelein 2003; Villadsgaard et al. 2007). Recordings of sounds produced by dwarf and pygmy sperm whales consist almost entirely of the click/pulse type. Porpoises, unlike most other odontocetes, do not produce whistles or do not whistle often (Awbrey et al. 1979; Bassett et al. 2009; Houck and Jefferson 1999; Richardson et al. 1995; Verboom and Kastelein 2003). High-frequency cetaceans also generate specialized clicks used in biosonar (echolocation) at frequencies above 100 kHz that are used to detect, localize, and characterize underwater objects such as prey (Richardson et al. 1995).

An auditory brainstem response study on a stranded pygmy sperm whale indicated best sensitivity between 90 to 150 kHz (Ridgway and Carder 2001). From a harbor porpoise audiogram using behavioral methods, detection thresholds were estimated from 250 Hz to 180 kHz, with the range of best hearing from 16 to 140 kHz and maximum sensitivity between 100 to 140 kHz (Kastelein et al. 2002b). While no empirical data on the hearing ability for Dall's porpoise are available, data on the morphology of the cochlea allow for estimation of the upper hearing threshold at about 170 to 200 kHz (Awbrey et al. 1979).

3.4.2.3.2 Mid-Frequency Cetaceans

Marine mammals within the mid-frequency cetacean functional hearing group are all odontocetes, and include the sperm whale (family Physeteridae); 32 species and subspecies of dolphins (family Delphinidae), the beluga and narwhal (family Monodontidae), and 19 species of beaked and bottlenose whales (family: Ziphiidae). The following members of the mid-frequency cetacean group are present or have a reasonable likelihood of being present in the Study Area: sperm whale, beaked whales (*Hyperoodon*, *Mesoplodon*, and *Ziphius* species), bottlenose dolphin, clymene dolphin, short-beaked common dolphin, long-beaked common dolphin, Fraser’s dolphin, killer whale, false killer whale, pygmy killer whale, melon-headed whale, short-finned pilot whale, long-finned pilot whale, Risso’s dolphin, rough-toothed dolphin, spinner dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, striped dolphin, white-beaked dolphin, Atlantic white-sided dolphin, narwhal, and beluga whale. Functional hearing in mid-frequency cetaceans is conservatively estimated to be between approximately 150 Hz and 160 kHz (Southall et al. 2007).

Hearing studies on cetaceans have focused primarily on odontocete species (see Kastelein et al. 2002b; Nachtigall et al. 2005; Szymanski et al. 1999; Yuen et al. 2005). Hearing sensitivity has been directly measured for a number of mid-frequency cetaceans, including Atlantic bottlenose dolphins (Johnson 1967), belugas (Finneran et al. 2005b; White et al. 1977), Indo-Pacific bottlenose dolphins (Houser et al.

2008), Black Sea bottlenose dolphins (Popov et al. 2007), striped dolphins (Kastelein et al. 2003), white-beaked dolphins (Nachtigall et al. 2008), Risso's dolphins (Nachtigall et al. 2005), killer whales (Szymanski et al. 1999), false killer whales (Yuen et al. 2005), common dolphins (Houser et al. 2010), Atlantic white-sided dolphins (Houser et al. 2010), Gervais' beaked whales (Finneran et al. 2009), and Blainville's beaked whales (Pacini et al. 2011). All audiograms exhibit the same general U-shape, with a functional hearing range between approximately 150 Hz and 160 kHz.

In general, odontocetes (including mid-frequency cetaceans) produce sounds across the widest band of frequencies. Their social vocalizations range from a few hundreds of Hz to tens of kHz (Southall et al. 2007) with source levels in the range of 100 to 170 dB re 1 µPa at 1 m (Richardson et al. 1995). As mentioned earlier, they also generate specialized clicks used in biosonar (echolocation) at frequencies above 100 kHz to detect, localize, and characterize underwater objects such as prey (Au 1993). Echolocation clicks have source levels that can be as high as 229 dB re 1 µPa peak-to-peak at 1 m (Au et al. 1974).

3.4.2.3.3 Low-Frequency Cetaceans

Marine mammals within the low-frequency functional hearing group are all mysticetes. This group comprises 13 species and subspecies of mysticete whales in five genera: *Balaena, Caperea, Eschrichtius, Megaptera,* and *Balaenoptera*. The following members of the low-frequency cetacean group (mysticetes) are present or have a reasonable likelihood of being present in the Study Area: bowhead whale, North Atlantic right whale, blue whale, Bryde's whale, fin whale, humpback whale, minke whale, and sei whale. Functional hearing in low-frequency cetaceans is conservatively estimated to be between about 7 Hz and 22 kHz (Southall et al. 2007).

Because of animal size and the availability of specimens, direct measurements of mysticete whale hearing are unavailable, although there was one effort to measure hearing thresholds in a stranded gray whale (Ridgway and Carder 2001). Because hearing ability has not been directly measured in these species, it is inferred from vocalizations, ear structure, and field observations. Vocalizations are audible somewhere in the frequency range of production, but the exact range cannot be inferred (Southall et al. 2007).

Mysticete cetaceans produce low-frequency sounds that range in the tens of Hz to several kHz that most likely serve social functions such as reproduction but may serve an orientation function as well (Green 1994; Green et al. 1994). Humpback whales are the notable exception within the mysticetes, with some calls exceeding 10 kHz. These sounds can be generally categorized as low-frequency moans; bursts or pulses; or more complex songs (Edds-Walton 1997). Source levels of most mysticete cetacean sounds range from 150 to 190 dB re 1 µPa at 1m (Richardson et al. 1995).

3.4.2.3.4 Pinnipeds

Pinnipeds are divided into three functional hearing groups: otariids (sea lions and fur seals), phocid seals (true seals), and odobenids (walrus) with different in-air and in-water hearing ranges. The Study Area only contains phocid seals and walrus. Otariid pinnipeds (sea lions and fur seals) are notably absent from the North Atlantic Ocean. Measurements of hearing sensitivity have been conducted on species representing all of the families of pinnipeds (Phocidae, Otariidae, Odobenidae)(Kastelein et al. 2002a; Kastelein et al. 2012a; Kastelein et al. 2005b; Moore and Schusterman 1987; Schusterman et al. 1972; Terhune 1988; Thomas et al. 1990a; Turnbull and Terhune 1990; Wolski et al. 2003).

Pinnipeds produce sounds both in air and water that range in frequency from approximately 100 Hz to 12 kHz, and it is believed that these sounds only serve social functions (Miller 1991) such as mother-pup recognition and reproduction. Source levels for pinniped vocalizations range from approximately 95 to 190 dB re 1 µPa at 1 m (Richardson et al. 1995).

3.4.2.3.4.1 Phocid Seals

Phocid seals (true seals) present or which have a reasonable likelihood of being present in the Study Area include the ringed seal, bearded seal, hooded seal, harp seal, gray seal, and harbor seal. Hearing in phocids has been tested in the following species: gray seals (Ridgway et al. 1975); harbor seals (Kastak and Schusterman 1998; Kastelein et al. 2012a; Kastelein et al. 2009a; Richardson et al. 1995; Southall et al. 2007; Terhune and Turnbull 1995; Wolski et al. 2003); harp seals (Terhune and Ronald 1971, 1972); Hawaiian monk seals (Thomas et al. 1990a); northern elephant seal (Kastak and Schusterman 1998; Kastak and Schusterman 1999); and ringed seals (Terhune and Ronald 1975, 1976).

Phocid functional hearing limits are estimated to be 75 Hz to 30 kHz in air and 75 Hz to 75 kHz in water (Kastak and Schusterman 1999; Kastelein et al. 2009a; Kastelein et al. 2009b; Møhl 1968a, b; Reichmuth 2008; Terhune and Ronald 1971, 1972).

3.4.2.3.4.2 Odobenids

The walrus is the only extant odobenid pinniped and may be found within the Study Area. The walrus is adapted to low-frequency sound with a range of best hearing underwater from 1 to 12 kHz and maximum hearing sensitivity around 12 kHz; its hearing ability falls off sharply at frequencies above 14 kHz (Kastelein et al. 2002c; Kastelein et al. 1996). The walrus hearing sensitivity is most similar to otariids, and therefore the walrus is assigned the same functional hearing range as for otariids (sea lions and fur seals) for this analysis. Functional hearing limits are conservatively estimated to be 50 Hz to 35 kHz in air and 50 Hz to 50 kHz in water (Southall et al. 2007).

Walruses make a wide variety of high-amplitude aerial and underwater sounds that range in frequency from 200 Hz to 10 kHz, including “bellows,” “barks,” “roars,” “bells,” clicks or pulses, grunts, and whistles (Kastelein et al. 2002c). Many of these vocalizations have social functions, while whistles are often produced during the mating season, and males use some for establishing territories and for courtship (Ray and Watkins 1975; Stirling et al. 1987; Verboom and Kastelein 1995).

3.4.2.3.5 Sirenians

The sirenian functional hearing group includes the manatees and dugong. The West Indian manatee is the only sirenian present in the Study Area. Behavioral data on manatees indicate they have an underwater hearing range of approximately 400 Hz to 76 kHz (Gerstein et al. 2008; Gerstein et al. 1999; Mann et al. 2009). Gerstein et al. (1999) obtained behavioral audiograms for two West Indian manatees and found an underwater hearing range of approximately 400 Hz to 76 kHz, with best sensitivity around 16 to 18 kHz. Mann et al. (2009) obtained masked behavioral audiograms from two manatees; sensitivity was shown to range from 250 Hz to 90 kHz, although the detection level at 90 kHz was 80 dB above the manatee’s frequency of lowest sensitivity (16 kHz). This audible frequency range is similar to that of phocids (Gerstein et al. 1999; Southall et al. 2007), and therefore manatees are assigned the same functional hearing range as that of phocid seals for this analysis.

Sirenians (manatees and dugongs) make underwater social sounds that range in frequency from 0.6 to 16 kHz, with West Indian manatees making sounds at lower frequencies than Amazonian manatees (Evans and Hearld 1970; Schevill and Watkins 1965). Source levels for manatee vocalizations have been recorded between 91 and 150 dB re 1 µPa at 1 m (Miksis-Olds and Tyack 2009; Nowacek et al. 2003; Phillips et al. 2004).

3.4.2.3.6 Polar Bear

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

3.4.2.4 General Threats to Marine Mammals

Marine mammal populations can be influenced by various natural factors and human activities. These factors affect marine mammal populations directly by injuring or inducing mortality outright, or indirectly by reducing survival or lowering reproductive success of individuals. Twiss and Reeves (1999) provide a general discussion of marine mammal conservation.

Marine mammals are influenced by natural phenomena such as storms and other extreme weather patterns. Generally, not much is known about how large storms and other weather patterns affect marine mammals, other than that mass strandings (when marine mammals swim or float into shore and become "beached" or stuck in shallow water) sometimes coincide with hurricanes, typhoons, and other tropical storms (Marsh 1989; Rosel and Watts 2008). The global climate is changing and is having very real impacts on some populations of marine mammals (Salvadeo et al. 2010; Simmonds and Eliott 2009). Climate change can affect marine mammal species directly through habitat loss (especially for species that depend on ice) and indirectly via impacts on prey, changing prey distributions and locations, and changes in water temperature. Changes in prey can impact marine mammal foraging success, which in turn affects reproduction success and survival. Climate change also may influence marine mammals through effects on human behavior, such as increased shipping and oil and gas extraction, which benefit from sea ice loss (Alter et al. 2010).

Mass die-offs of some marine mammal species have been linked to consumption of toxic plankton or other organisms, such as die-offs of California sea lions and northern fur seals because of poisoning caused by the diatom *Pseudo-nitzschia* spp. (Doucette et al. 2006; Fire et al. 2008; Lefebvre 2010; Thomas et al. 2010; Torres de la Riva et al. 2009). 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). Disease affects some individuals, especially older animals, and occasionally disease epidemics can injure or kill a large percentage of the population (Keck et al. 2010; Paniz-Mondolfi and Sander-Hoffmann 2009).

Human impacts on marine mammals have received much attention in recent decades and include hunting (both commercial and native practices), fisheries interactions (such as gear entanglement, shootings by fishermen, or bycatch [accidental or indirect catch]), ship strikes, noise and chemical pollution, and general habitat deterioration or destruction.

Direct hunting, as in whaling and sealing operations, provided the original impetus for marine mammal management and has driven much of the early research on cetaceans and pinnipeds (Twiss and Reeves

1999). However, bycatch of animals in fishing nets and gear is likely an even bigger problem today and may account for the deaths of more marine mammals than any other cause (Hamer et al. 2010; Northridge 2008; Read 2008). In 1994, the MMPA was amended to formally address bycatch. At least in part as a result of the amendment, development of a take reduction plan is required when a bycatch exceeds a level considered unsustainable by the marine mammal population. Estimates of bycatch in the Atlantic declined by a total of 59 percent from 1994 to 2006 (Geijer and Read 2013). Cetacean bycatch declined by 44 percent from 3,153 in 1994 to 1,764 in 2006, and pinniped bycatch declined from 81 percent from 2,210 to 476 over the same time period. Ship strikes are also a growing issue for most marine mammals, such as North Atlantic right whales (Huntington 2009; Knowlton and Kraus 2001). Ship strikes may negatively impact the population of a species, particularly in small populations and possibly on larger scales (Laist et al. 2001; Van Waerebeek et al. 2007; Vanderlaan et al. 2009).

Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, avoiding predators, and communicating with other individuals. Noise can cause behavioral disturbances, mask other sounds including their own vocalizations, and may even result in injury and in some cases, may lead to death (Tyack 2009; Würsig and Richardson 2008). Human-caused noises in the marine environment come from shipping, seismic and geologic exploration, military activity, and other types of pulses produced by government, commercial, industry, and private sources. In addition, noise from whale-watching vessels in the vicinity of marine mammals has recently received a great deal of attention (Wartzok 2009).

Chemical pollution is also of great concern, although for the most part, its effects on marine mammals are just starting to be understood (Reijnders et al. 2008). Recently, the 5.5-year expedition of the *Odyssey* collected 955 biopsy samples from sperm whales around the world to provide a consistent baseline database of ocean contamination against which to measure future effects (Ocean Alliance 2010). Chemical pollutants and pesticides flow into the marine environment from human use on land and are absorbed into the bodies of marine mammals, accumulating in their blubber (this process is often called bioaccumulation) or transferring to the young via mothers' milk (Fair et al. 2010). Important factors that determine the levels of pesticides and industrial pollutants that accumulate in marine mammals are gender (i.e., adult males have no way to transfer pesticides whereas females may pass pollutants to their calves through milk), habitat, and diet. Living closer to the source of pollutants and feeding on higher-level organisms increase the potential to accumulate toxins (Moon et al. 2010). The buildup of human-made persistent compounds in marine mammals not only increases their likelihood of contracting diseases or developing tumors but also compromises the function of their reproductive systems (Fair et al. 2010). The risk of negative health effects is particularly high when contaminants are transferred to a calf through its mother's milk (Fair et al. 2010).

Oil and other chemical spills are a specific type of ocean contamination known to have negative effects on some marine mammal species (Matkin et al. 2008). In April 2010, the *Deepwater Horizon* offshore drill rig, 41 miles (mi. [66 kilometers {km}]) (Nowacek et al. 2004b) southeast of the Louisiana coast, exploded and sank during exploratory well drilling. The effects of this disaster are just beginning to be studied, and it will likely be many years before impacts are understood. Although information on effects of oil spills on marine mammals is limited, they can be affected both directly by the oil and indirectly by activities during the containment and cleanup phases and through impacts on prey and habitat. Marine mammals can be impacted by the changes in habitat from the presence of chemicals and dispersants in their habitat, by oil introduction, and from increased human presence in the environment. Any of these factors may trigger changes in prey distribution, water quality, noise levels, and other environmental variables.

Potential behavioral responses to spills include displacement from primary habitat and the disruption of social structure, changes in prey availability and in feeding activities and success, effects on reproductive behavior, and changes to migration. Potential physical/physiological effects are irritation, inflammation, necrosis (premature death of living tissue), and chemical burns of skin, eyes, and nose areas, and inhalation of toxic fumes with potential long-term respiratory effects, such as inflammation, pulmonary emphysema, and infection (Engelhardt 1983; Marine Mammal Commission 2010). Ingestion of oil and dispersants directly or through feeding on contaminated prey (such as krill [very small shrimp-like animals] and squid), which have eaten dispersants, can lead to short or longer-term effects from inflammation, ulcers, bleeding, and possible damage to liver, kidney, and brain tissues (Engelhardt 1983; Marine Mammal Commission 2010). After the *Exxon Valdez* spill of 1987 in Prince William Sound, Alaska, pulmonary emphysema was a relatively common finding in sea otters exposed to toxic fumes, and brain lesions were observed in harbor seals (Marine Mammal Commission 2010). Two of the resident killer whale pods found in Prince William Sound before the spill declined by 33 and 40 percent after the spill. One of those pods has not reproduced successfully since, and the other pod has not fully recovered (Marine Mammal Commission 2010).

In addition to the direct effects of oil and dispersants, cleanup and containment operations also may have an effect on marine mammals. Cleanup includes containing oil in booms, skimming oil at the ocean surface, and burning. Cleanup also involves a large number of vessels and aircraft in the coastal and offshore habitats bringing increased noise levels and human presence into marine mammal habitats. These activities could stress and disturb marine mammals, potentially displacing them from important feeding or breeding grounds and disrupting normal behavior (Marine Mammal Commission 2010).

General habitat deterioration and loss is a major factor for almost all coastal and inshore species of marine mammals, especially those that live in rivers or estuaries, and it may include such factors as depleting a habitat’s prey base and the complete loss of habitat (Kemp 1996; Smith et al. 2009).

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

3.4.2.5 North Atlantic Right Whale (*Eubalaena glacialis*)

Right whales in the North Atlantic and North Pacific were once classified together as a single species, the northern right whale. However, genetic data have now determined them to represent two separate species: the North Atlantic right whale (*Eubalaena glacialis*) and the North Pacific right whale (*Eubalaena japonica*) (Rosenbaum et al. 2000).

3.4.2.5.1 Status and Management (Excerpts from Waring et al. (2013))

The North Atlantic right whale population is considered one of the most critically endangered populations of large whales in the world (Clapham et al. 1999). The size of this stock is considered extremely low relative to the Optimum Sustainable Population in the U.S. Atlantic Exclusive Economic Zone, and this species is listed as endangered under the ESA. A recovery plan for the North Atlantic right whale is in effect (U.S. Department of Commerce 2005). The North Atlantic right whale was also protected from commercial whaling by the International Whaling Commission since 1927. An NMFS ESA status review in 1996 concluded that the western North Atlantic stock remains endangered. This conclusion was reinforced by the International Whaling Commission (Best et al. 2003), which expressed grave concern regarding the status of this stock. Relative to populations of southern right whales, there are also concerns about growth rate, percentage of reproductive females, and calving intervals in the

North Atlantic right whale population. The total level of human-caused mortality and serious injury is unknown, but reported human-caused mortality was a minimum of three right whales per year from 2006 through 2010. Any mortality or serious injury for this stock should be considered significant. This is a strategic stock because the average annual human-related mortality and serious injury exceeds potential biological removal and because the North Atlantic right whale is an endangered species.

Three critical habitats—Cape Cod Bay/Massachusetts Bay/Stellwagen Bank, Great South Channel, and the coastal waters of Georgia and Florida in the southeastern United States—were designated by NMFS in 1994 (FR 59: 28805, June 3, 1994) (Figure 3.4-1). Two additional critical habitat areas in Canadian waters, Grand Manan Basin and Roseway Basin, were identified in Canada's final recovery strategy for the North Atlantic right whale (Brown et al. 2009). A 12-month finding from NMFS on a 2002 petition to revise right whale critical habitat stated "a review of scientific information suggests that physical and biological features essential to the conservation of right whales may include, but are not necessarily limited to, the occurrence of copepods and the features that concentrate them in the water off of the northeast United States, as well as sea surface temperature and possibly bathymetry in the waters off of the southeast United States. In a more recent 12-month finding on a 2009 petition, NMFS stated they agree that revision of critical habitat is appropriate and that they would continue the ongoing rulemaking process (FR 75 (193): 61690-61691, October 6, 2010).

3.4.2.5.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

The western North Atlantic right whale population ranges primarily from calving grounds in coastal waters of the southeastern United States to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence. Knowlton et al. (1992) reported several long-distance movements as far north as Newfoundland, the Labrador Basin, and southeast of Greenland. In addition, recent resightings of photographically identified individuals were made off Iceland, in the old Cape Farewell whaling ground east of Greenland (Hamilton et al. 2007), and northern Norway (Jacobsen et al. 2004). The September 1999 Norwegian sighting represents one of only two published sightings this century of a right whale in Norwegian waters, and the first since 1926. Together, these long-range matches indicate an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described. The few published records from the Gulf of Mexico (Moore and Clark 1963; Schmidly et al. 1972; Ward-Geiger et al. 2011) represent either distributional anomalies, normal wanderings of occasional animals, or a more extensive historic range beyond the sole known calving and wintering ground in the waters of the southeastern United States. Whatever the case, the location of much of the population is unknown during the winter.

Research results suggest the existence of six major habitats or congregation areas for western North Atlantic right whales: winter breeding grounds in the coastal waters of the southeastern United States within the Southeast U.S. Continental Shelf Large Marine Ecosystem and summer feeding grounds within the Northeast U.S. Continental Shelf Large Marine Ecosystem–Great South Channel, Georges Bank/Gulf of Maine, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf.

However, movements within and between habitats are extensive. In 2000, one whale was photographed in Florida waters on 12 January, then again 11 days later (23 January) in Cape Cod Bay, less than a month later off Georgia (16 February), and back in Cape Cod Bay on 23 March, effectively making the round-trip migration to the southeast and back at least twice during the winter (Brown and Marx 2000). Results from satellite tags clearly indicate that sightings separated by perhaps two weeks should not necessarily be assumed to indicate a stationary or resident animal. Instead, telemetry data show rather lengthy and

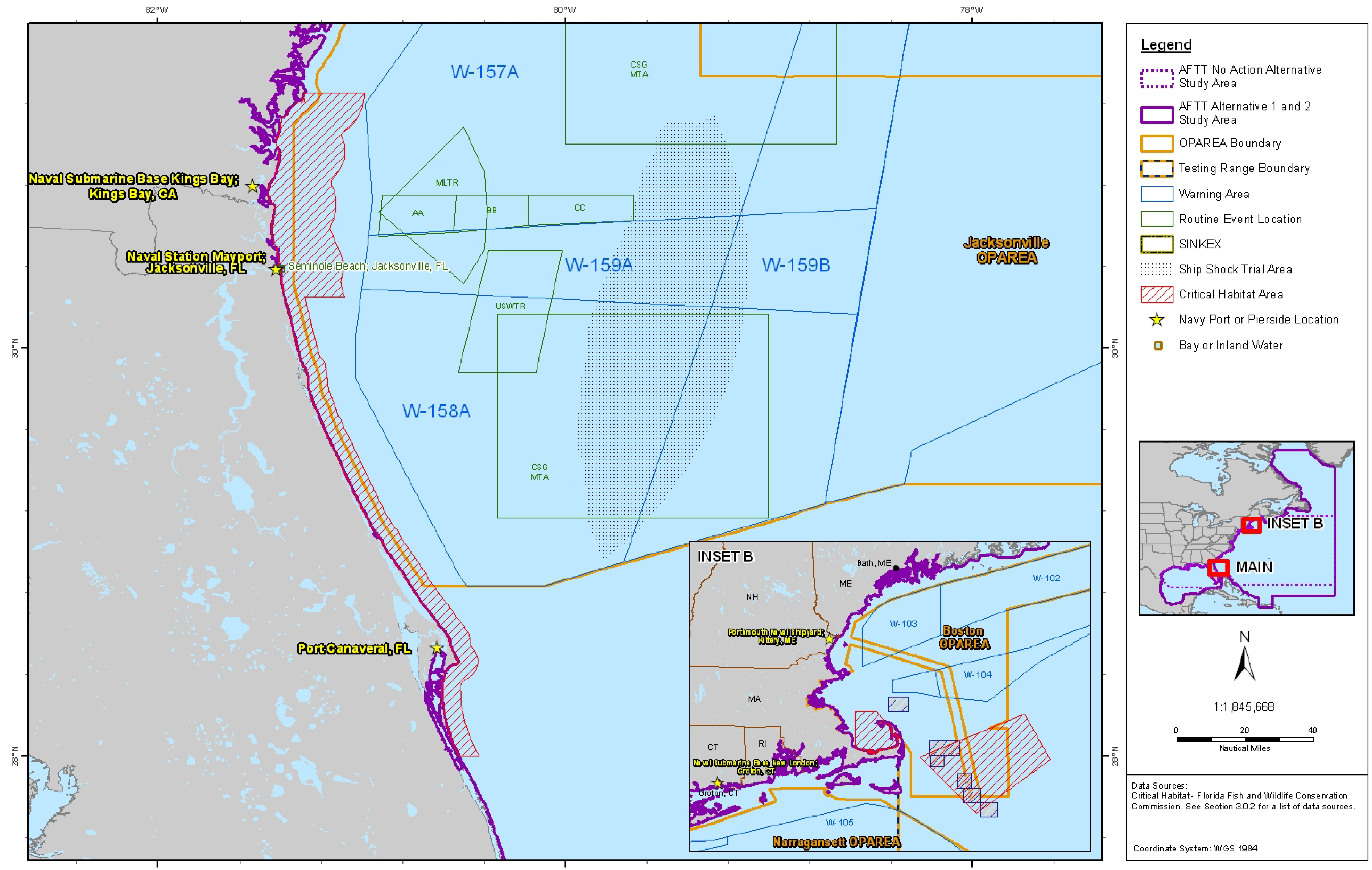

Figure 3.4-1: Designated Critical Habitat Areas for North Atlantic Right Whale in the Study Area

AFTT: Atlantic Fleet Training and Testing; CSG MTA: Carrier Strike Group Mine Training Area; CT: Connecticut; FL: Florida; GA: Georgia; MA: Massachusetts; MLTR: Missile Laser Training Range; ME: Maine; NH: New Hampshire; OPAREA: Operating Area; RI: Rhode Island; SINKEX: Sinking Exercise; USWTR: Undersea Warfare Training Range

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somewhat distant excursions, including into deep water off the continental shelf (Baumgartner and Mate 2005; Mate et al. 1997). Systematic surveys conducted off the coast of North Carolina during the winters of 2001 and 2002 sighted eight calves, suggesting the calving grounds may extend as far north as Cape Fear. Four of the calves were not sighted by surveys conducted further south. One of the cows photographed was new to researchers, having effectively eluded identification over the period of its maturation (McLellan et al. 2004).

Three right whale observations (four individuals) were recorded during aerial surveys sponsored by the Navy approximately 50 mi. (80 km) offshore of Jacksonville, Florida, in 2009 and 2010, including a female that was observed giving birth (Foley et al. 2011). These sightings occurred well outside existing critical habitat for the right whale and suggest that the calving area may be broader than currently assumed (Foley et al. 2011; U.S. Department of the Navy 2010). Offshore (greater than 30 mi. [48.3 km]) surveys flown off the coast of northeastern Florida and southeastern Georgia from 1996 to 2001 documented 3 sightings in 1996, 1 in 1997, 13 in 1998, 6 in 1999, 11 in 2000, and 6 in 2001 (within each year, some were repeat sightings of previously recorded individuals). Several of the years that offshore surveys were flown were some of the lowest count years for calves and for numbers of right whales in the southeast recorded since comprehensive surveys in the calving grounds were initiated. Therefore, the frequency with which right whales occur in offshore waters in the southeastern United States remains unclear.

Since 2004, consistent aerial survey efforts have been conducted during the migration and calving season (15 November to 15 April) in coastal areas of Georgia and South Carolina, to the north of currently defined critical habitat (Glass and Taylor 2006; Khan and Taylor 2007; Sayre and Taylor 2008; Schulte and Taylor 2010). Results suggest that this region may not only be part of the migratory route but also a seasonal residency area. Results from an analysis by Schick et al. (2009) suggest that the migratory corridor of North Atlantic right whales is broader than initially estimated and that suitable habitat exists beyond the 20 nautical mile (nm) coastal buffer presumed to represent the primary migratory pathway (National Marine Fisheries Service 2008b). Results were based on data modeled from two females tagged with satellite-monitored radio tags as part of a previous study.

New England waters are an important feeding habitat for right whales, which feed primarily on copepods in this area (largely of the genera *Calanus* and *Pseudocalanus*). Research suggests that right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990). These dense zooplankton patches are likely a primary characteristic of the spring, summer, and fall right whale habitats (Kenney et al. 1986; Kenney et al. 1995). While feeding in the coastal waters off Massachusetts has been better studied than in other areas, right whale feeding has also been observed on the margins of Georges Bank, in the Great South Channel, in the Gulf of Maine, in the Bay of Fundy, and over the Scotian Shelf. The characteristics of acceptable prey distribution in these areas are beginning to emerge (Baumgartner and Mate 2003; Baumgartner and Mate 2005). NMFS and Provincetown Center for Coastal Studies aerial surveys during springs of 1999–2006 found right whales along the northern edge of Georges Bank, in the Great South Channel, in Georges Basin, and in various locations in the Gulf of Maine including Cashes Ledge, Platts Bank, and Wilkinson Basin. The consistency with which right whales occur in such locations is relatively high, but these studies also highlight the high interannual variability in right whale use of some habitats.

3.4.2.5.3 Population and Abundance (Excerpts from Waring et al. (2013))

The western North Atlantic minimum stock size is based on a census of individual whales identified using photo-identification techniques. Review of the photo-identification recapture database as it existed in

21 October 2011 indicated that 425 individually recognized whales in the catalog were known to be alive during 2009. Whales catalogued by this date included 20 of the 39 calves born during that year. Adding the 19 calves not yet catalogued brings the minimum number alive in 2009 to 444. This value is a minimum and does not include animals alive prior to 2008, but not recorded in the individual sightings database as seen from 1 December 2008 to 21 October 2011 (note that matching of photos taken during 2010-2011 was not complete at the time the data were received). This estimate has no associated coefficient of variation. In 2010, the best estimate of catalogued North Atlantic right whales was 490 individuals (Hamilton et al. 2011). This estimate does not include potentially unphotographed whales and is an estimate of the cataloged population only.

The population growth rate reported for the period 1986–1992 by Knowlton et al. (1994) was 2.5 percent (CV=0.12), suggesting that the stock was showing signs of slow recovery. However, subsequent work suggested that survival declined from about 0.99 in the early 1980s to about 0.94 in the late 1990s (Best et al. 2001; Caswell et al. 1999; Clapham 2002). Recent mortalities, including those in the first half of 2005, suggest an increase in the annual mortality rate (Kraus et al. 2005). Despite the preceding, examination of the minimum number alive population index calculated from the individual sightings database (as it existed on 21 October 2011) for 1990–2009 suggests a positive trend in numbers. These data reveal a significant increase in the number of catalogued whales alive during this period with a mean growth of 2.6 percent.

3.4.2.5.4 Predator/Prey Interactions

The North Atlantic right whale preys primarily on the copepod *Calanus finmarchicus* (a type of zooplankton) and on other copepods and small invertebrates, such as krill and larval barnacles (Jefferson et al. 2008b). Right whales are skim feeders and are known to feed below or at the surface (Kenney et al. 2001) or within a few meters of the seafloor on near-bottom aggregations of copepods (Baumgartner 2009; Baumgartner et al. 2009; Warren 2009). The copepod *Calanus finmarchicus* is one of the most common species of prey found throughout the North Atlantic right whale’s range (Baumgartner and Mate 2003; Jefferson et al. 2008b).

The North Atlantic right whale is preyed on by killer whales and large sharks. Calves and juveniles are known to be the primary target of killer whales, and analysis of scars on some individuals suggests that they are also attacked by false killer whales (Kenney 2008).

3.4.2.5.5 Species-Specific Threats (Excerpts from Waring et al. (2013))

Primary sources of human-caused serious injury and mortality include entanglement in fishing gear and ship strikes. Entanglement records from 1990 through 2007 maintained by NMFS Northeast Regional Office included 46 confirmed right whale entanglements, including right whales in weirs (stationary nets fixed in place), gillnets, and trailing line and buoys. Because whales often free themselves of gear following an entanglement event, scarring may be a better indicator of fisheries interaction than entanglement records. In an analysis of the scarification of right whales, 338 of 447 (75.6 percent) whales examined during 1980–2002 were scarred at least once by fishing gear (Knowlton et al. 2005). Ship strikes pose a particularly serious threat to the North Atlantic right whale. Vessel speed as well as angle of approach can determine the severity of ship strikes (Silber et al. 2010). Research shows that the probability of right whales dying after being struck by a ship is more than 80 percent when a vessel is traveling at 15 knots or more; when speeds are reduced to 10 knots or less, the chance of mortality drops to just above 20 percent. To reduce the number of ship strikes, NMFS has established regulations (FR 73 (198): 60173-60191, October 10, 2008) imposing speed restrictions in seasonal management areas for commercial ships 65 ft. or longer. In addition, the Navy has adopted standard operating procedures for protecting right whales from ship strikes (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). For additional detail on ship strikes and right whales, refer to Section 3.4.3.3.1 (Impacts from Vessels) and Section 3.4.3.3.2 (Impacts from In-Water Devices).

3.4.2.6 Bowhead Whale (*Balaena mysticetus*)

Bowhead whales are the northernmost of all whales, inhabiting only arctic and subarctic regions, often close to the ice edge.

3.4.2.6.1 Status and Management

The bowhead whale is listed as endangered under the ESA and is designated as depleted under the MMPA. Three geographically distinct bowhead whale stocks are recognized in the Atlantic – the Spitsbergen, Baffin Bay-Davis Straight, and Hudson Bay-Fox Basin stocks (Allen and Angliss 2010; Rugh et al. 2003; Wiig et al. 2007). Because these stocks do not occur within U.S. Atlantic waters, they are not managed under NMFS jurisdiction.

3.4.2.6.2 Habitat and Geographic Range

Bowhead whales are found in arctic and subarctic regions of the Atlantic and Pacific oceans (55° N to 85° N). They are also found in the Bering, Beaufort, Chukchi, and Okhotsk Seas, as well as in the northern parts of Hudson Bay (Wiig et al. 2007). Their range can expand and contract depending on access through ice-filled Arctic straits (Rugh et al. 2003). Habitat selection varies seasonally, although this is clearly the most polar species of whale. Bowheads are found in continental slope waters during spring and summer while feeding on abundant zooplankton (Wiig et al. 2007).

Migration occurs within the Arctic and is associated with ice edge movements. Bowheads reside in the high Arctic during summer and move south in fall as the ice edge grows, spending their winters in lower-latitude areas (Jefferson et al. 2008b). The Davis Strait stock spends winters from Labrador across to West Greenland and moves north to spend summers in the Canadian High Arctic and around Baffin Island (Heide-Jorgensen et al. 2003). Whales in the Beaufort Sea were observed changing their migratory routes in response to noise associated with oil production (Huntington 2009).

Newfoundland-Labrador Shelf and West Greenland Shelf Large Marine Ecosystem. The southernmost portion of the bowhead range includes the shelf areas of west Greenland and northern Labrador. Bowheads were sighted in the continental slope waters of west Greenland during April (Ledwell et al. 2007). From May 2002 to December 2003, satellite-tracked bowheads departed from west Greenland and moved northwest toward Lancaster Sound. Individuals remained within the Canadian High Arctic or along the east coast of Baffin Island in summer and early fall. By the end of October, whales moved rapidly south along the east coast of Baffin Island and entered Hudson Strait (Heide-Jorgensen et al. 2006). Two bowhead whales were stranded on Newfoundland in 1998 and 2007, from 45° N to 47° N and 52° W to 56° W, representing the southernmost records of this species in the western North Atlantic (Ledwell et al. 2007).

3.4.2.6.3 Population and Abundance

Aerial surveys were used to estimate the Davis Strait stock of bowheads (Wiig et al. 2007). The combined Davis Strait-Hudson Bay stocks are now thought to number at least 7,000 (Cosens et al. 2006). The International Whaling Commission estimates the bowhead stock off west Greenland at 490–2,940 individuals (95 percent confidence interval).

3.4.2.6.4 Predator/Prey Interactions

Bowheads feed by skimming the surface or sometimes near the seafloor (Rugh and Shelden 2009). Preferred prey are various species of copepods and euphausiids (Budge et al. 2008; Rugh and Shelden 2009; Wiig et al. 2007). Killer whales are the primary natural predator of the bowhead whale (George et al. 1994). Scars from killer whale attacks are observed on some individuals (Jefferson et al. 2008b; Rugh and Shelden 2009).

3.4.2.6.5 Species-Specific Threats

Threats to bowhead whales include ship strikes, entanglement in fishing gear, contaminants, and anthropogenic noise, especially from offshore oil drilling. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.7 Humpback Whale (*Megaptera novaeangliae*)

The humpback whale may be the best known and most recognizable of all the great whales (a descriptive term referring to the larger baleen whales and the sperm whale). It is the focus of many whale-watching operations worldwide.

3.4.2.7.1 Status and Management

Humpback whales are listed as endangered under the ESA and depleted under the MMPA. Critical habitat has not been designated for humpback whales. Based on overall evidence of population recovery in many areas, the species is being considered by NMFS for removal or down-listing from the ESA (FR 74 (154): 40568, August 12, 2009).

Although the western North Atlantic population was once treated as a single management stock, the Gulf of Maine stock is now considered separate based on strong fidelity of humpbacks to that region (Waring et al. 2010). The Gulf of Maine stock is the only stock of humpbacks in the Atlantic managed under NMFS jurisdiction.

3.4.2.7.2 Habitat and Geographic Range

Humpback whales are distributed worldwide in all major oceans and most seas. They typically are found during the summer on high-latitude feeding grounds and during the winter in the tropics and subtropics around islands, over shallow banks, and along continental coasts, where calving occurs. Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep oceanic waters during migration (Calambokidis et al. 2001; Clapham and Mattila 1990). Their primary range in the Atlantic includes the nearshore waters of the Northeast U.S. Continental Shelf, Scotian Shelf, and Newfoundland-Labrador Shelf Large Marine Ecosystems. Their secondary range includes the Southeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems, as well as the Labrador Current, Gulf Stream and North Atlantic Gyre Open Ocean Areas.

Humpback feeding habitats are typically shallow banks or ledges with high seafloor relief (Hamazaki 2002; Payne et al. 1990). On breeding grounds, females with calves occur in much shallower waters than other groups of whales, and breeding adults use deeper more offshore waters (Ersts and Rosenbaum 2003; Smultea 1994). The habitat requirements of wintering humpbacks appear to be controlled by the conditions necessary for calving, such as warm water (75° Fahrenheit [F] to 82°F [24° Celsius {C} to 28°C]) and relatively shallow, low-relief ocean bottom in protected areas, created by islands or reefs (Clapham 2000; Craig and Herman 2000; Smultea 1994).

Humpback whales typically migrate from the northern feeding areas such as the Gulf of Maine (including Georges Bank, southwestern Nova Scotia, and the Bay of Fundy) or the Scotian Shelf to calving/breeding areas in the West Indies, where the majority of whales are found, particularly off the Dominican Republic, north of the territory of Turks and Caicos on Silver Bank, Navidad Bank, and in Samana Bay, though some whales were sighted in the Cape Verde Islands off the west coast of Africa (Waring et al. 2010). Individual variability in the timing of migrations may result in the presence of individuals in high-latitude areas throughout the year (Straley 1990).

Newfoundland-Labrador and Scotian Shelf Large Marine Ecosystems. The Gulf of St. Lawrence, Newfoundland Grand Banks, and Scotian Shelf are summer feeding grounds for humpbacks (Cetacean and Turtle Assessment Program 1982; Kenney and Winn 1986; Stevick et al. 2006; Whitehead 1982).

Northeast U.S. Continental Shelf Large Marine Ecosystem. The Gulf of Maine is one of the principal summer feeding grounds for humpback whales in the North Atlantic. The largest numbers of humpback whales are present from mid-April to mid-November. Other feeding locations in this ecosystem are Stellwagen Bank, Jeffreys Ledge, the Great South Channel, the edges and shoals of Georges Bank, Cashes Ledge, and Grand Manan Banks (Cetacean and Turtle Assessment Program 1982; Kenney and Winn 1986; Stevick et al. 2006; Weinrich et al. 1997; Whitehead 1982). Humpbacks are most likely to occur in the Chesapeake Bay between January and March; however, they could be found in the area year-round, based on sighting and stranding data in both mid-Atlantic waters and the Chesapeake Bay itself (Barco et al. 2002; Swingle et al. 2007). Photo-identification data support the repeated use of the mid-Atlantic region by individual humpback whales (Barco et al. 2002). Barco et al.'s study suggests the mid-Atlantic region might be where some mother humpbacks wean and separate from their calves.

3.4.2.7.3 Population and Abundance (Excerpts from Waring et al. (2013))

The best available estimate for the entire North Atlantic population (including the Gulf of Maine stock) derived from photographic mark-recapture analyses from the Years of the North Atlantic Humpback project is 11,570. The most recent line-transect survey, which did not include the Scotian Shelf portion of the stock, produced an estimate of abundance for Gulf of Maine humpback whales of 331 animals (CV=0.48) with a resultant minimum population estimate for this stock of 228 animals. The line-transect based on minimum population estimate is unrealistic because at least 500 uniquely identifiable individual whales from the Gulf of Maine stock were seen during the calendar year of that survey and the actual population would have been larger because re-sighting rates of Gulf of Maine humpbacks have historically been less than 1. Using the minimum count from at least two years prior to the year of a stock assessment report allows time to resight whales known to be alive prior to and after the focal year. Thus, the minimum population estimate is set to the 2008 mark-recapture-based count of 823.Current data suggest that the Gulf of Maine humpback whale stock is steadily increasing in numbers. This is consistent with an estimated average trend of 3.1 percent (SE=0.005) in the North Atlantic population overall for the period 1979–1993 (Stevick et al. 2003).

3.4.2.7.4 Predator/Prey Interactions

Humpback whales feed on a variety of invertebrates and small schooling fishes. The most common invertebrate prey are krill; the most common fish prey are herring, mackerel, sand lance, sardines, anchovies, and capelin (Clapham and Mead 1999). Feeding occurs both at the surface and in deeper waters, wherever prey is abundant. The humpback whale is the only species of baleen whale that shows strong evidence of cooperation when feeding in large groups (D'Vincent et al. 1985). Humpback whales were observed using “bubble nets” to herd prey (Jefferson et al. 2008b). Bubble nets are a feeding strategy where the whales dive and release bubbles of air that float up in a column and trap prey inside; the humpbacks then lunge through the column of trapped prey to feed.

Friedlaender et al. (2009) analyzed the relationship between humpback whale foraging and prey abundance on Stellwagen Bank, Massachusetts. Sensors on the whales allowed the researchers to measure in fine detail the orientation and movement patterns of both humpback whales and their prey at meaningful ecological scales (Friedlaender et al. 2009). They found that differences between surface and bottom feeding behaviors in humpback whales correlated with vertical changes in the distribution and abundance of their primary prey, sand lance. Hazen et al. (2009) showed that in addition to prey abundance, other factors relate to humpback whale surface feeding in the Gulf of Maine, such as time of day and the height of the tides. Characteristics of the prey, such as light emitted and the shape of the schools formed by the prey, also relate to humpback whale surface-feeding.

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. 2008b).

3.4.2.7.5 Species-Specific Threats (Excerpts from Waring et al. (2013))

As with right whales, human impacts (vessel collisions and entanglements) may be slowing recovery of the humpback whale population. Of 20 dead humpback whales (principally in the mid-Atlantic region, where decomposition did not preclude examination for human impacts), Wiley et al. (1995) reported that six (30 percent) had major injuries possibly attributable to ship strikes, and five (25 percent) had injuries consistent with possible entanglement in fishing gear. One whale displayed scars that may have been caused by both ship strike and entanglement. Thus, 60 percent of the whale carcasses suitable for examination showed signs that anthropogenic factors may have contributed to, or been responsible for, their death.

3.4.2.8 Minke Whale (*Balaenoptera acutorostrata*)

Minke whales are the smallest species of mysticete in the AFTT Study Area and are classified as a single species with three subspecies recently recognized: *Balaenoptera acutorostrata davidsoni* in the North Atlantic, *Balaenoptera acutorostrata scammoni* in the North Pacific, and a subspecies that is formally unnamed but generally called the dwarf minke whale, which mainly occurs in the southern hemisphere (Jefferson et al. 2008b).

3.4.2.8.1 Status and Management (Excerpts from Waring et al. (2013))

The minke whale is protected under the MMPA but is not listed under the ESA. In the North Atlantic, there are four recognized populations: Canadian east coast, west Greenland, central North Atlantic, and northeastern North Atlantic (Donovan 1991). Minke whales off the eastern coast of the United States are considered to be part of the Canadian east coast stock, which inhabits the area from the western half of the Davis Strait (45°W) to the Gulf of Mexico. The relationship between this stock and the other three stocks is uncertain.

3.4.2.8.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

Minke whales have a cosmopolitan distribution in temperate and tropical waters and generally occupy waters over the continental shelf, including inshore bays and even occasionally estuaries. However, records from whaling catches and research surveys worldwide indicate there may be an open-ocean component to the minke whale's habitat (Ingram et al. 2007; Jefferson et al. 2008b), including the Labrador Current, Gulf Stream, and North Atlantic Gyre Open Ocean Areas. They have an extensive distribution in polar, temperate, and tropical waters in the northern and southern hemispheres (Jefferson et al. 2008b; Perrin and Brownell 2008); they are less common in the tropics than in cooler waters.

Minke whales generally participate in annual migrations between low-latitude breeding grounds in the tropics and subtropics in the winter and high-latitude feeding grounds (such as Gulf of Maine as well as the Saguenay-St. Lawrence region [Quebec]) in the summer (Kuker et al. 2005). Migration paths of the common minke whale show they follow patterns of prey availability (Jefferson et al. 2008b).

The minke whale is common and widely distributed within the U.S. Exclusive Economic Zone in the Atlantic Ocean (Cetacean and Turtle Assessment Program 1982). There appears to be a strong seasonal component to minke whale distribution. Like most other baleen whales, minke whales generally occupy the continental shelf proper rather than the continental shelf edge region. Records summarized by Mitchell (1991) hint at a possible winter distribution in the West Indies, and in the mid-ocean south and east of Bermuda. As with several other cetacean species, the possibility of a deep-ocean component to the distribution of minke whales exists but remains unconfirmed.

Scotian Shelf Large Marine Ecosystem. The St. Lawrence Estuary is known as a summer feeding ground for the North Atlantic population of the minke whale (Edds-Walton 2000).

Northeast U.S. Continental Shelf Large Marine Ecosystem. During summer and early fall, minke whales are found throughout the lower Bay of Fundy (Ingram et al. 2007). Spring and summer are times of relatively widespread and common occurrence, and are the seasons when the whales are most abundant in New England waters. In New England waters during fall there are fewer minke whales, while during winter the species appears to be largely absent.

Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems. Minke whales occur in the warmer waters of the southern United States during winter. Although they are not typically expected to occur within the Gulf of Mexico, observation records exist for mostly immature individuals in the Gulf of Mexico and Florida Keys (Stewart and Leatherwood 1985; Waring et al. 2013).

3.4.2.8.3 Population and Abundance

The minke whale is considered generally abundant in most areas of its range (Horwood 1990; Jefferson et al. 2008b). Although global population abundance is difficult to assess, estimates for the North Atlantic indicate there are more than 100,000 whales in the region and possibly more than 180,000 in the northern hemisphere (Jefferson et al. 2008b; Perrin and Brownell 2008; Skaug et al. 2004). Multiple estimates are available for portions of minke whale habitat. The best recent abundance estimate for this stock is 20,741 (CV=0.30) minke whales. This is the estimate derived from the Canadian Trans-North Atlantic Sighting Survey in July-August 2007 and is considered best because, while it did not cover any U.S. waters, the survey covered more of the minke whale range than the other surveys reported (Waring et al. 2013). The minimum population estimate for the Canadian East Coast minke whale is 16,199 animals.

3.4.2.8.4 Predator/Prey Interactions

This species preys on small invertebrates and schooling fishes, such as capelin, haddock, sand eels, pollock, herring, and cod (Jefferson et al. 2008b; Kuker et al. 2005; Lindstrom and Haug 2001; Reeves et al. 2002b). 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).

Minke whales are prey for killer whales (Ford et al. 2005); a common minke was observed under attack by killer whales near British Columbia (Weller 2008).

3.4.2.8.5 Species-Specific Threats

Minke whales are documented as bycatch in gillnets in the mid-Atlantic and northeast fisheries. This species was also documented as bycatch in pelagic longline fisheries operating in the Atlantic Ocean, Caribbean, and Gulf of Mexico (Zollett 2009). Section 3.4.2.4 (General Threats to Marine Mammals) discusses general threats to marine mammals.

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

Bryde's whales are among the least known of the baleen whales. Their classification and true numbers remain uncertain (Alves et al. 2010). Some scientists suggest that there may be up to three species (Bryde's whale, *Balaenoptera brydei*, Bryde's/Eden's whale, *Balaenoptera edeni* [Olsen 1913], and Omura's whale, *Balaenoptera omurai* (Wada et al. 2003) based on geographic distribution, inshore/offshore forms, and a pygmy form. For at least two of the species, the scientific name *B. edeni* is commonly used. The Bryde's whale's "pygmy form" has only recently been described and is now known as Omura's whale (Kato and Perrin 2008; Rice 1998). The International Whaling Commission continues to use the name *Balaenoptera edeni* for all Bryde's-like whales, although at least two species are recognized.

3.4.2.9.1 Status and Management

Bryde's whale is protected under the MMPA but not listed under the ESA. Current genetic research confirms that gene flow among Bryde's whale populations is low and suggests that management actions treat each as a distinct entity to ensure survival of the species (Kanda et al. 2007). Bryde's whales found in the northern Gulf of Mexico may represent a resident stock and are thus considered a separate stock for management purposes; however, there are no data to suggest genetic differentiation from the North Atlantic stock (Waring et al. 2010).

3.4.2.9.2 Habitat and Geographic Range

Unlike other baleen whale species, Bryde's whales are restricted to tropical and subtropical waters and do not generally occur beyond latitude 40° in either the northern or southern hemisphere (Jefferson et al. 2008b; Kato and Perrin 2008). The primary range of Bryde's whales in the Atlantic is in tropical waters south of the Caribbean, outside the Study Area, except for the Gulf of Mexico, where this species is thought to be the most common baleen (Würsig et al. 2000), although they may range as far north as Virginia (Kato and Perrin 2008). Long migrations are not typical of Bryde's whales, although limited shifts in distribution toward and away from the equator in winter and summer were observed (Best 1996; Cummings 1985).

Gulf of Mexico Large Marine Ecosystem. In the Gulf of Mexico, Bryde's whales were sighted near the shelf break in DeSoto Canyon (Davis et al. 2000; Davis and Fargion 1996; Jefferson and Schiro 1997). Most of the sighting records of Bryde's whales in the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico) are from NMFS abundance surveys, which were conducted during the spring (Davis et al. 2000; Davis and Fargion 1996; Hansen et al. 1996; Hansen et al. 1995; Jefferson and Schiro 1997; Maze-Foley and Mullin 2006; Mullin and Fulling 2004; Mullin and Hoggard 2000). However, there are stranding records from throughout the year (Würsig et al. 2000).

3.4.2.9.3 Population and Abundance

The best abundance estimate available for northern Gulf of Mexico Bryde's whales is 33 (CV=1.07). This estimate is from a summer 2009 oceanic survey covering waters from the 200 m isobath to the seaward extent of the U.S. Exclusive Economic Zone. The minimum population estimate for the northern Gulf of Mexico is 16 Bryde's whales. There are insufficient data to assess population trends for this species (Waring et al. 2013).

3.4.2.9.4 Predator/Prey Interactions

Bryde's whales primarily feed on schooling fishes and are lunge feeders. Prey includes anchovy, sardine, mackerel, herring, krill, and pelagic red crab (Baker and Madon 2007; Jefferson et al. 2008b; Nemoto and Kawamura 1977). Like humpback whales, Bryde's whales were observed using "bubble nets" to herd prey (Jefferson et al. 2008b; Kato and Perrin 2008). Bryde's whale is 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 2008).

3.4.2.9.5 Species-Specific Threats

There are no significant species-specific threats to Bryde's whales in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.10 Sei Whale (*Balaenoptera borealis*)

The sei whale is one of at least three genetically distinct species of medium-sized rorquals, including the so-called pygmy or dwarf Bryde's whale (Kato and Perrin 2008; Rice 1998) and a new species, Omura's whale (*Balaenoptera omurai*). Many aspects of sei whale behavior and ecology are poorly understood, and this species is one of the least known rorquals.

3.4.2.10.1 Status and Management

The sei whale is listed as endangered under the ESA and depleted under the MMPA. Critical habitat is not designated for sei whales. A recovery plan for the sei whale was finalized in 2011 (National Marine Fisheries Service 2011). There are two stocks for the sei whale in the North Atlantic: a Nova Scotia stock and a Labrador Sea stock (Waring et al. 2013). The Nova Scotia stock is considered the management unit under NMFS jurisdiction; it includes the continental shelf waters of the northeastern United States, and extends northeastward to south of Newfoundland.

3.4.2.10.2 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 from 20° N to 23° N and during the summer from 35° N to 50° N (Horwood 2009; Masaki 1976, 1977; Smultea et al. 2010). They are considered absent or at very low densities in most equatorial areas and in the Arctic Ocean (U.S. Department of Commerce 2010).

Sei whales spend the summer feeding in subpolar high latitudes and return to lower latitudes to calve in winter. Whaling data provide some evidence of varied migration patterns, based on reproductive class, with females arriving at and departing from feeding areas earlier than males (Horwood 1987; Perry et al. 1999). Sei whales are known to swim at speeds greater than 15 mi. (25 km) per hour and may be the fastest cetacean, after the fin whale (Horwood 1987; Jefferson et al. 2008b).

Labrador Current, North Atlantic Gyre, and Gulf Stream Open Ocean Areas. Sei whales are typically found in the open ocean and are rarely observed near the coast (Horwood 2009; Jefferson et al. 2008b). They are generally found between 10° and 70° latitudes. Satellite tagging data indicate sei whales feed and migrate east to west across large sections of the North Atlantic (Olsen et al. 2009); they are not often seen within the equatorial Atlantic. In the Study Area, the open ocean range includes the Labrador Current, North Atlantic Gyre, and Gulf Stream Open Ocean Areas.

Scotian Shelf and Northeast U.S. Continental Shelf Large Marine Ecosystems. The range of the Nova Scotia stock includes the continental shelf waters of the northeastern United States and extends northeastward to south of Newfoundland. During the feeding season, a large portion of the Nova Scotia sei whale stock is centered in northerly waters of the Scotian Shelf (Waring et al. 2013).

The southern portion of the species' range during spring and summer includes the northern portions of the U.S. Exclusive Economic Zone in the Atlantic Ocean, including the Gulf of Maine and Georges Bank. During spring and summer, sei whales occur in waters from the Bay of Fundy to northern Narragansett Bay. High concentrations are often observed along the northern flank, eastern tip, and southern shelf break of Georges Bank. During the fall, sei whales may be found in limited shelf areas of the Northeast Channel and in the western Gulf of Maine (Cetacean and Turtle Assessment Program 1982; Stimpert et al. 2003). Spring is the period of greatest abundance in Georges Bank and into the Northeast Channel area, along the Hydrographer Canyon (Cetacean and Turtle Assessment Program 1982; Waring et al. 2010).

3.4.2.10.3 Population and Abundance (Excerpts from Waring et al. (2013))

Commercial whaling in the 19th and 20th centuries depleted populations in all areas throughout the species' range, though they appear to be recovering in the northern hemisphere as a result of legal protection. Current global abundance is considered a minimum of 80,000 (Horwood 1987; Jefferson et al. 2008b). However, the abundance of sei whales in the Atlantic Ocean remains unknown. An August 2004 abundance estimate of 386 individuals is considered the best available for the Nova Scotia stock of sei whales. However, this estimate must be considered conservative in view of the known range of the sei whale in the entire western North Atlantic and the uncertainties regarding population structure and whale movements between surveyed and unsurveyed areas. The Nova Scotia stock minimum population estimate is 208 (Waring et al. 2013).

3.4.2.10.4 Predator/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). Sei whales, like other baleen whales, are likely subject to occasional attacks by killer whales.

3.4.2.10.5 Species-Specific Threats

There are no significant species-specific threats to sei whales in the northwest Atlantic. Section 3.4.2.4 (General Threats to Marine Mammals) discusses general threats to marine mammals.

3.4.2.11 Fin Whale (*Balaenoptera physalus*)

The fin whale is found in all of the world's oceans, except the Arctic Ocean, and is the second largest species of whale (Jefferson et al. 2008b). Fin whales have two recognized subspecies: *Balaenoptera physalus physalus* occurs in the North Atlantic Ocean, while *B. p***.** *quoyi* occurs in the Southern Ocean.

3.4.2.11.1 Status and Management (Excerpts from Waring et al. (2013))

The fin whale is endangered under the ESA and is depleted under the MMPA. A final recovery plan was published in July 2010 for fin whales in U.S. waters. In the North Atlantic Ocean, the International Whaling Commission recognizes seven management stocks of fin whales: (1) Nova Scotia, (2) Newfoundland-Labrador, (3) West Greenland, (4) East Greenland-Iceland, (5) North Norway, (6) West Norway-Faroe Islands, and (7) British Isles-Spain-Portugal (U.S. Department of Commerce 2010). The western North Atlantic fin whale stock was assessed for management.

Fin whales off the eastern United States, Nova Scotia and the southeastern coast of Newfoundland are believed to constitute a single stock under the present International Whaling Commission scheme (Donovan 1991) and are currently considered the management unit under NMFS jurisdiction. However, the stock identity of North Atlantic fin whales has received relatively little attention, and whether the current stock boundaries define biologically isolated units has long been uncertain.

3.4.2.11.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

Fin whales prefer temperate and polar waters and are rarely seen in warm tropical waters (Reeves et al. 2002a). They typically congregate in areas of high productivity and spend most of their time in coastal and shelf waters but can often be found in waters approximately 2,000 m deep (Aissi et al. 2008; Reeves et al. 2002a). Fin whales are often seen closer to shore after periodic patterns of upwelling (underwater motion) and the resultant increased krill density (Azzellino et al. 2008). This species is not known to have specific habitat preferences and is highly adaptable, following prey, typically off the continental shelf (Azzellino et al. 2008; Panigada et al. 2008).

Fin whales are common in waters of the U.S. Atlantic Exclusive Economic Zone, principally from Cape Hatteras northward, accounting for 46 percent of the large whales and 24 percent of all cetaceans sighted over the continental shelf during aerial surveys (Cetacean and Turtle Assessment Program 1982) between Cape Hatteras and Nova Scotia during 1978–82. In the Study Area, fin whales occur in summer foraging areas from the coast of North America to the Arctic, around Greenland, Iceland, northern Norway, and the Barents Sea. In the western Atlantic, they winter from the edge of sea ice south to the Gulf of Mexico and the West Indies (U.S. Department of Commerce 2010).

Hain et al. (1992) suggested that calving takes place during October to January in latitudes of the U.S. mid-Atlantic region; however, it is unknown where calving, mating, and wintering occur for most of the population. Results from the Navy's Sound Surveillance System program (Clark 1995) indicate a substantial deep-ocean distribution of fin whales. It is likely that fin whales occurring in the U.S. Exclusive Economic Zone in the Atlantic Ocean undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions. However, the popular notion that entire fin whale populations make distinct annual migrations like some other mysticetes has questionable support in the data; in the North Pacific, year-round monitoring of fin whale calls found no evidence for large-scale migratory movements (Watkins et al. 2000).

Open Ocean. The open ocean range of the fin whale includes the Gulf Stream, North Atlantic Gyre, and Labrador Current.

Northeast U.S. Continental Shelf Large Marine Ecosystem. Fin whales are common off the Atlantic coast of the United States in waters immediately off the coast seaward to the continental shelf (about the 1,000-fathom contour). In this region, they tend to occur north of Cape Hatteras where they accounted for about 46 percent of the large whales observed in surveys conducted between 1978 and

1982 (U.S. Department of Commerce 2010). During the summer, fin whales in this region tend to congregate in feeding areas between 41°20' N and 51°00' N, from shore seaward to the 1,000-fathom contour.

In the summer, fin whales are observed in the Gulf of Maine, the Bay of Fundy, the Gulf of St. Lawrence and St. Lawrence Estuary, and in offshore areas of Nova Scotia (Coakes et al. 2005; Johnston et al. 2005). Near the Bay of Fundy, fin whales are known to congregate close to the tip of Campobello Island, where they feed within localized upwellings and fronts in the Northeast U.S. Continental Shelf Large Marine Ecosystem (Johnston et al. 2005). New England waters are considered a major feeding ground for fin whales, and there is evidence that females continually return to this site (Waring et al. 2010). Forty-nine percent of fin whales sighted in the feeding grounds of Massachusetts Bay were sighted again within the same year, and 45 percent were sighted again in multiple years (Waring et al. 2010). Aerial observations in Onslow Bay, North Carolina, from August 2009 through August 2010 resulted in the sighting of a single fin whale (U.S. Department of the Navy 2010).

3.4.2.11.3 Population and Abundance

The best abundance estimate for the western North Atlantic fin whale stock is 3,522 (CV=0.27). The minimum population estimate for the western North Atlantic fin whale is 2,817 (Waring et al. 2013).

3.4.2.11.4 Predator/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. 2008b). 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 possible predation by killer whales (Aguilar 2008).

3.4.2.11.5 Species-Specific Threats

Fin whales are susceptible to both ship strikes and entanglement in fishing gear. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.12 Blue Whale (*Balaenoptera musculus*)

Blue whales are the largest species of animal on earth and are divided into three subspecies — northern hemisphere blue whale (*Balaenoptera musculus musculus*), Antarctic blue whale (*Balaenoptera musculus intermedia*), and the pygmy blue whale (*Balaenoptera musculus brevicauda*)

3.4.2.12.1 Status and Management

Blue whales are listed as endangered under the ESA and depleted under the MMPA. Critical habitat is not designated for blue whales. A recovery plan is in place for the blue whale in U.S. waters (Reeves 1998b). Blue whales in the western North Atlantic are classified as a single stock (Waring et al. 2010).

Widespread whaling over the last century is believed to have decreased the population to approximately 1 percent of its pre-whaling population size, although some authors have concluded that their population numbers were about 200,000 animals before whaling (Branch 2007; Sirovic et al. 2004). There was a documented increase in the blue whale population size between 1979 and 1994, but there is no evidence to suggest an increase in the population since then (Barlow 1994; Barlow and Taylor 2001; Carretta et al. 2010).

3.4.2.12.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

The distribution of the blue whale in the western North Atlantic generally extends from the Arctic to at least mid-latitude waters. Blue whales are most frequently sighted in the waters off eastern Canada, with the majority of recent records from the Gulf of St. Lawrence (Sears et al. 1987). The blue whale is best considered as an occasional visitor in U.S. Atlantic Exclusive Economic Zone waters, which may represent the current southern limit of its feeding range (Cetacean and Turtle Assessment Program 1982; Wenzel et al. 1988). All five sightings described in the foregoing two references were in August. Yochem and Leatherwood (1985) summarized records that suggested an occurrence of this species south to Florida and the Gulf of Mexico, although the actual southern limit of the species' range is unknown. Using the U.S. Navy's Sound Surveillance System program, blue whales were detected and tracked acoustically in much of the North Atlantic, including in subtropical waters north of the West Indies and in deep water east of the U.S. Atlantic Exclusive Economic Zone, indicating the potential for long-distance movements (Clark 1995). Most of the acoustic detections were around the Grand Banks area of Newfoundland and west of the British Isles. Historical blue whale observations collected by Reeves et al. (2004) show a broad longitudinal distribution in tropical and warm temperate latitudes during the winter months, with a narrower, more northerly distribution in summer.

Newfoundland-Labrador Shelf Large Marine Ecosystem. Members of the North Atlantic population spend much of their time on continental shelf waters from eastern Canada (near the Quebec north shore) to the St. Lawrence Estuary and Strait of Belle Isle. Sightings were reported along the southern coast of Newfoundland during late winter and early spring (Reeves et al. 2004).

Scotian Shelf Large Marine Ecosystem. Blue whales are most frequently sighted in the waters off eastern Canada. Most records come from the Gulf of St. Lawrence (Waring et al. 2013).

Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems. Although the exact extent of their southern boundary and wintering grounds are not well understood, blue whales are occasionally found in waters off of the U.S. Atlantic coast (Waring et al. 2013).

Caribbean Sea and Gulf of Mexico Large Marine Ecosystems. Blue whale strandings have been recorded as far south as the Caribbean and the Gulf of Mexico (Waring et al. 2010).

3.4.2.12.3 Population and Abundance (Excerpts from Waring et al. (2013))

Little is known about the population size of blue whales in the Northwest Atlantic except for the Gulf of St. Lawrence area, and current data do not allow for an estimate of abundance of this stock. Mitchell (1974) estimated that the blue whale population in the western North Atlantic may number only in the low hundreds. The photo identification catalogue count of 440 recognizable individuals from the Gulf of St. Lawrence is considered a minimum population estimate for the western North Atlantic stock.

3.4.2.12.4 Predator/Prey Interactions

This species preys almost exclusively on various types of zooplankton, especially krill. They lunge feed and consume approximately six tons (5,500 kilograms [kg]) of krill per day (Jefferson et al. 2008b; Pitman et al. 2007). They sometimes feed at depths greater than 100 m, where their prey maintains dense groupings (Acevedo-Gutiérrez et al. 2002). Blue whales are documented as preyed on by killer whales (Jefferson et al. 2008b; Pitman et al. 2007). There is little evidence that killer whales attack this species in the North Atlantic or southern hemisphere, but 25 percent of photo-identified whales in the Gulf of California carry rake scars from killer whale attacks (Sears and Perrin 2008).

3.4.2.12.5 Species-Specific Threats

Threats for North Atlantic blue whales are poorly known but may include ship strikes, pollution, entanglement in fishing gear, and long-term changes in climate that may affect their prey distribution. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.13 Sperm Whale (*Physeter macrocephalus*)

Sperm whales are the largest of the odontocetes (toothed whales) and the most sexually dimorphic cetaceans, with males considerably larger than females. The sperm whale's extremely large head takes up to 25 to 35 percent of its total body length.

3.4.2.13.1 Status and Management

There are currently three stocks of sperm whales recognized within the Study Area managed under NMFS jurisdiction in the North Atlantic, Gulf of Mexico, and Puerto Rico and U.S. Virgin Islands. The sperm whale has been listed as a single endangered species since 1970 under the precursor to the ESA (National Marine Fisheries Service 2009) and is depleted under the MMPA. In 2011 NMFS received a petition to list the Gulf of Mexico stock as a Distinct Population Segment and in a 90-day finding announced that the petition presented substantial scientific or commercial information indicating that the petitioned action may be warranted (78 FR (61): 19176-19178, March 29, 2013). As a result, NMFS initiated a status review of sperm whales in the Gulf of Mexico to determine whether the petitioned action is warranted. Critical habitat is not designated for sperm whales, although the petition for the Gulf of Mexico Distinct Population Segment also requested that critical habitat be designated. A five-year review for sperm whales was finalized in 2009 (National Marine Fisheries Service 2009).

3.4.2.13.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

Sperm whales are found throughout the world's oceans in deep waters to the edge of the ice at both poles (Leatherwood and Reeves 1983; Rice 1989; Whitehead 2002). Sperm whales show a strong preference for deep waters (Rice 1989; Whitehead 2003). Their distribution is typically associated with waters over the continental shelf break, over the continental slope, and into deeper waters. However, in some areas, adult males are reported to consistently frequent waters with bottom depths less than 330 ft. (100 m) and as shallow as 40 m (Jefferson et al. 2008b; Romero et al. 2001). 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 and Praca 2007; Jefferson et al. 2008b).

The distribution of the sperm whale in the U.S. Exclusive Economic Zone occurs on the continental shelf edge, over the continental slope, and into mid-ocean regions. Waring et al. (1993; Waring et al. 2001) suggest that this offshore distribution is more commonly associated with the Gulf Stream edge and other features. However, the sperm whales that occur in the eastern U.S. Exclusive Economic Zone in the Atlantic Ocean likely represent only a fraction of the total stock. The nature of linkages of the U.S. habitat with those to the south, north, and offshore is unknown. Historical whaling records compiled by Schmidly (1981) suggested an offshore distribution off the southeast United States, over the Blake Plateau, and into deep ocean waters. In the southeast Caribbean, both large and small adults, as well as calves and juveniles of different sizes are reported (Watkins et al. 1985). Whether the northwestern Atlantic population is discrete from northeastern Atlantic is currently unresolved. The International Whaling Commission recognizes one stock for the North Atlantic, based on reviews of many types of stock studies (i.e., tagging, genetics, catch data, mark-recapture, biochemical markers, etc.).

In winter, sperm whales are concentrated east and northeast of Cape Hatteras. In spring, the center of distribution shifts northward to east of Delaware and Virginia and is widespread throughout the central portion of the mid-Atlantic Bight and the southern portion of Georges Bank. In summer, the distribution is similar but now also includes the area east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf (inshore of the 100-m isobath) south of New England. In the fall, sperm whale occurrence south of New England on the continental shelf is at its highest level, and there remains a continental shelf edge occurrence in the mid-Atlantic Bight. Similar inshore (less than 200 m) observations were made on the southwestern and eastern Scotian Shelf, particularly in the region of "the Gully" (Whitehead and Weilgart 1991).

Open Ocean. Sperm whales are found throughout the Gulf Stream and North Atlantic Gyre. In 1972, extensive survey cruises covering much of the western and central North Atlantic Ocean found high densities of sperm whales in the Gulf Stream region, between 40° N and 50° N, over the North Atlantic Ridge (National Marine Fisheries Service 2006).

Newfoundland-Labrador Shelf Large Marine Ecosystem. High densities of sperm whales were found in the Grand Banks of Newfoundland (National Marine Fisheries Service 2006).

Scotian Shelf Large Marine Ecosystem. Off Nova Scotia, coastal whalers found sperm whales primarily in deep continental slope waters, especially in submarine canyons and around the edges of banks. During late spring and throughout the summer, this species is found on the continental shelf in waters less than 100 m deep on the southern Scotian Shelf and into the northeast United States (National Marine Fisheries Service 2006; Palka 2006).

Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems. Distribution along the east coast of the United States is centered along the shelf break and over the slope. During winter, high densities occur in inner slope waters east and northeast of Cape Hatteras, North Carolina (National Marine Fisheries Service 2006; Palka 2006; Waring et al. 2010). In spring, distribution shifts northward to Delaware and Virginia, and the southern portion of Georges Bank. Summer and fall distribution is similar, extending to the eastern and northern portions of Georges Bank and north into the Scotian Shelf. Occurrence south of New England on the continental shelf is highest in the fall (Waring et al. 2010). Aerial surveys in August 2009 off the Virginia coast resulted in the sighting of two sperm whales (U.S. Department of the Navy 2010). Aerial observations in Onslow Bay, North Carolina, from August 2009 through August 2010 resulted in the sighting of one sperm whale (U.S. Department of the Navy 2010). Aerial surveys conducted between August 2009 and August 2010 off Jacksonville, Florida, resulted in the sighting of one sperm whale.

Gulf of Mexico Large Marine Ecosystem. The sperm whale is the most common large cetacean in the northern Gulf of Mexico (Palka and Johnson 2007). Sperm whales aggregate at the mouth of the Mississippi River and along the continental slope in or near cyclonic cold-core eddies (counterclockwise water movements in the northern hemisphere with a cold center) (Davis et al. 2007). O'Hern and Biggs (2009) showed that most sperm whale groups were found within regions of enhanced sea surface chlorophyll. The distribution of sperm whales in the Gulf of Mexico is strongly linked to surface oceanography, such as loop current eddies that locally increase production and availability of prey (O'Hern and Biggs 2009). In the north-central Gulf of Mexico, sperm whales are especially common near the Mississippi Canyon, where some are present year-round, and mixed groups of females and bachelor groups of males are found.

In the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico), systematic aerial and ship surveys indicate that sperm whales inhabit continental slope and oceanic waters where they are widely distributed (Fulling et al. 2003; Maze-Foley and Mullin 2006; Mullin and Fulling 2004; Mullin and Hoggard 2000; Mullin et al. 2004). Seasonal aerial surveys confirm that sperm whales are present in the northern Gulf of Mexico in all seasons (Hansen et al. 1996; Mullin et al. 1994a; Mullin and Hoggard 2000). The information for southern Gulf of Mexico waters is more limited, but there are sighting and stranding records from each season with sightings widely distributed in continental slope waters of the western Bay of Campeche (Ortega-Ortiz 2002).

Caribbean Sea Large Marine Ecosystem. In waters surrounding Puerto Rico and the U.S. Virgin Islands, NMFS winter ship surveys indicate that sperm whales inhabit continental slope and oceanic waters (Roden and Mullin 2000; Swartz and Burks 2000; Swartz et al. 2002). Earlier sightings from the northeastern Caribbean were reported by Erdman (1970), Erdman et al. (1973) and Taruski and Winn (1976), and these and other sightings from Puerto Rican waters are summarized by Mignucci-Giannoni (1988). Mignucci-Giannoni found 43 records for sperm whales up to 1989 for waters of Puerto Rico, U.S. Virgin Islands, and British Virgin Islands, and suggested they occur from late fall through winter and early spring but are rare from April to September. In addition, sperm whales are one of the most common species to strand in waters of Puerto Rico and the Virgin Islands (Mignucci-Giannoni et al. 1999).

3.4.2.13.3 Population and Abundance (Excerpts from Waring et al. (2013))

Several estimates from selected regions of sperm whale habitat exist for select time periods; however, at present there is no reliable estimate of total sperm whale abundance in the western North Atlantic (Palka 2006; Waring et al. 2010). In 2004, a survey of waters from Maryland to the Bay of Fundy yielded an abundance estimate of 2,607, and a survey of waters from Florida to Maryland resulted in an abundance estimate of 2,197. Sightings have been almost exclusively in the continental shelf edge and continental slope areas. The best recent abundance estimate for sperm whales is 1,593 (CV=0.36) resulting from a 2011 survey (Palka 2012). Because all sperm whale estimates presented here were not corrected for dive-time, they are likely downwardly biased and an underestimate of actual abundance. The minimum population estimate for the western North Atlantic sperm whale is 3,539.

The best abundance estimate available for northern Gulf of Mexico sperm whales is 1,665 (CV=0.20) (Mullin 2007). This estimate is pooled from summer 2003 and spring 2004 oceanic surveys covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone. The minimum population estimate for the northern Gulf of Mexico is 1,409 sperm whales.

The best abundance estimate available for the Puerto Rico and U.S. Virgin Islands stock of sperm whales is unknown, and data are currently insufficient to calculate a minimum population estimate for this stock of sperm whales.

3.4.2.13.4 Predator/Prey Interactions

Sperm whales socialize for predator defense but also for foraging. Sperm whales feed on squid, other cephalopods (a type of mollusc), and bottom-dwelling fish and invertebrates (Davis et al. 2007; Marcoux et al. 2007; Rice 1989). Exactly how sperm whales search for, detect, and capture their prey remains uncertain. Jaquet and Gendron (2009) suggest that site-specific ecological factors, such as predation pressure and food availability, likely influence fundamental aspects of sperm whale social organization. False killer whales, pilot whales, and killer whales have been documented harassing and on occasion attacking sperm whales (Baird 2009b).

3.4.2.13.5 Species-Specific Threats

There are no significant species-specific threats to sperm whales in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.14 Dwarf/Pygmy Sperm Whale (*Kogia sima* and *Kogia breviceps*)

Before 1966, dwarf and pygmy sperm whales were thought to be a single species, until form and structure distinction was shown (Handley 1966); misidentifications of these two species are still common (Jefferson et al. 2008b). *Kogia* spp. are not often observed at sea, but they are among the more frequently stranded cetaceans (Caldwell and Caldwell 1989; Jefferson et al. 2008b; McAlpine 2009). Rare sightings indicate they may avoid human activity, and they are rarely active at the sea surface. They usually appear slow and sluggish, often resting motionless at the surface with no visible blow (Baird 2005; Jefferson et al. 2008b).

3.4.2.14.1 Status and Management

Kogia spp. are protected under the MMPA but not listed under the ESA. Although virtually nothing is known of population status for these species, stranding frequency suggests they may not be as uncommon as sighting records would suggest (Jefferson et al. 2008b; Maldini et al. 2005). The western North Atlantic population and the northern Gulf of Mexico population are considered separate stocks for management purposes, but there is no genetic evidence that these two populations differ (Waring et al. 2010).

3.4.2.14.2 Habitat and Geographic Range

Dwarf and pygmy sperm whales appear to be distributed worldwide in temperate to tropical waters (Caldwell and Caldwell 1989; McAlpine 2002). *Kogia* can occur close to shore and sometimes over the outer continental shelf. However, several studies show that they may also generally occur beyond the continental shelf edge (Bloodworth and Odell 2008; MacLeod et al. 2004). The pygmy sperm whale may frequent more temperate habitats than the dwarf sperm whale, which is more of a tropical species. Data from the Gulf of Mexico suggest that *Kogia* spp. may associate with frontal regions along the continental shelf break and upper continental slope, where squid densities are higher (Baumgartner et al. 2001; Jefferson et al. 2008b). Although deep oceanic waters may be the primary habitat for this species, there are very few oceanic sighting records offshore. The lack of sightings may have more to do with the difficulty of detecting and identifying these animals at sea and lack of effort than with any real distributional preferences.

In the Study Area, this species is found primarily in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems, the Gulf of Mexico, and Caribbean Sea (Bloodworth and Odell 2008; Caldwell and Caldwell 1989; Cardona-Maldonado and Mignucci-Giannoni 1999). A stranded pygmy sperm on the north shore of the Gulf of St. Lawrence represents the northernmost record for this species in the western Atlantic (Measures et al. 2004).

Pygmy sperm whales were one of the most commonly sighted species in the northern Gulf of Mexico from 1992 to 1994 and from 1996 to 2001 (Mullin and Fulling 2004). Fulling and Fertl (2003)noted a concentration of sightings in continental slope waters near the Mississippi River Delta. The delta is considered an important area for cetaceans in the northern Gulf of Mexico because of its high levels of productivity associated with oceanographic features.

3.4.2.14.3 Population and Abundance

Because *Kogia sima* and *Kogia breviceps* are difficult to differentiate at sea, the reported abundance estimates prior to the 2011 estimate are for both species of *Kogia*. The best abundance estimate for dwarf sperm whales is the result of a shipboard and aerial survey conducted during June–August 2011 (Palka 2012)—1,042 (CV=0.65). The minimum population estimate for dwarf sperm whales is 632 animals. The best abundance estimate for pygmy sperm whales from the 2011 survey is 741 (CV=0.40) (Palka 2012). The minimum population estimate for dwarf sperm whales is 535 animals (Waring et al. 2013).

3.4.2.14.4 Predator/Prey Interactions

Kogia feed on cephalopods and, less often, on deep-sea fishes and shrimp (Beatson 2007; Caldwell and Caldwell 1989). A study showed cephalopods (squid) were the primary prey of pygmy sperm whales in the Pacific Ocean, making up 78.7 percent of prey abundance and 93.4 percent contribution by mass. Stomach samples revealed an extreme diversity of cephalopod prey, with 38 species from 17 families (West et al. 2009).

Kogia are likely subject to occasional killer whale predation, as are other whale species.

3.4.2.14.5 Species-Specific Threats

There are no significant species-specific threats to *Kogia* in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.15 Beluga Whale (*Delphinapterus leucas*)

The beluga whale is a member of the family Monodontidae, which it shares with the narwhal, *Monodon monoceros.* Belugas can be confused with female narwhals, which overlap with their range and are superficially similar in appearance.

3.4.2.15.1 Status and Management

Beluga whales are protected under the MMPA, although the only stock that is managed under NMFS jurisdiction occurs outside of the Study Area, in Cook Inlet, Alaska. There are three recognized stocks of belugas that may occur within the Study Area: St. Lawrence, Eastern High Arctic/Baffin Bay, and West Greenland (Jefferson et al. 2008b). These stocks are endangered under Canada's Species at Risk Act (Her Majesty the Queen in Right of Canada 2003).

3.4.2.15.2 Habitat and Geographic Range

This species' distribution nearly spans the Arctic and is found only in high latitudes of the northern hemisphere. Belugas are found in Arctic and subarctic waters along the northern coasts of Canada, Alaska, Russia, Norway, and Greenland (O'Corry-Crowe 2008; Stewart and Stewart 1989). Distribution is centered mainly between 49° N and 80° N from the west coast of Greenland to eastern Scandinavia.

Belugas occur primarily in shallow coastal waters, as shallow as 1 to 3 m. They can also be found in offshore waters greater than 800 m deep (Jefferson et al. 2008a; Richard et al. 2001). During the winter, belugas are believed to occur in offshore waters associated with pack ice, but little is known about the distribution, ecology, or behavior in winter. In most regions, belugas are believed to migrate in the direction of the advancing polar ice front. However, in some areas, they may remain behind this front and overwinter in enclosed areas of unfrozen water and ice leads. In the spring, they migrate to warmer shallow water in coastal estuaries, bays, and rivers for molting and calving (North Atlantic Marine Mammal Commission 2000).

West Greenland Shelf and Newfoundland-Labrador Shelf Large Marine Ecosystems. This species is known to occur in the extreme northwestern portion of the Study Area. The St. Lawrence Estuary is at the southern limit of the distribution of this species (Jefferson et al. 2008a; O'Corry-Crowe 2008). A population of greater than 1,100 is known to reside in the St. Lawrence Estuary year-round (Lebeuf et al. 2007). On the west coast of Greenland, belugas are found from Qaanaaq in the north to Paamiut in the south in the fall, winter, and spring. Belugas are rare along this coast in summer (North Atlantic Marine Mammal Commission 2000).

3.4.2.15.3 Population and Abundance

The global population is relatively well studied and is estimated at 150,000 (Jefferson et al. 2008a; O'Corry-Crowe 2008). The St. Lawrence stock is estimated at 900 to 1,000, the Eastern High Arctic/Baffin Bay stock at 21,213, and the West Greenland stock at 7,941 (Jefferson et al. 2008a).

3.4.2.15.4 Predator/Prey Interactions

Beluga whales prey on various types of fish and invertebrates. In some parts of their range, it is clear that belugas are feeding in nearshore waters on seasonally abundant coastal fishes, such as salmon, herring, capelin, smelt, and saffron cod. Much of their prey depends on distribution and seasonal availability (Jefferson et al. 2008a).

Killer whales and polar bears both are predators of belugas.

3.4.2.15.5 Species-Specific Threats

There are no significant species-specific threats to beluga whales in the Northwest Atlantic. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.16 Narwhal (*Monodon monoceros*)

Narwhals, along with beluga whales, are members of the Monodontidae family, sometimes referred to as the "white whales." The most conspicuous characteristic of the male narwhal is its single 7–10 ft. (2–3 m) long tusk, an incisor tooth that projects from the left side of the upper jaw.

3.4.2.16.1 Status and Management

The narwhal is not listed under the ESA and is protected under the MMPA. There is no stock that occurs in the U.S. Exclusive Economic Zone in the Atlantic Ocean; however, populations from Hudson Strait and Davis Strait may extend into the Study Area at its northwest extreme (Heide-Jorgensen 2009).

3.4.2.16.2 Habitat and Geographic Range

Being the cetacean with the northernmost range, narwhals prefer cold Arctic waters. They are also known to be a deepwater species. In the summer, they are found in more northern areas, and as ice begins to form, they tend to follow the ice to more open waters for the winter. They are often found in deep fjords and cracks and leads in the ice (Heide-Jorgensen 2009; Reeves and Tracey 1980).

Newfoundland-Labrador Shelf Large Marine Ecosystem. Narwhals winter in the regions of Hudson Strait and Baffin Bay-Davis Strait, as well as Disko Bay. Narwhals wintering in Hudson Strait in smaller numbers are assumed to belong to the northern Hudson Bay summer population. Tagged narwhals in the summering grounds in Admiralty Inlet showed their annual migration following the ice during the autumn to more open waters of Melville Bay and Eclipse Sound in central and southern Baffin Bay and northern Davis Strait (Dietz et al. 2008; Heide-Jorgensen 2009). Before the fast ice forms in the fall, narwhals move into deep water along the edge of the continental shelf, with depths of up to 1,000 to 2,000 m (Heide-Jorgensen 2009).

3.4.2.16.3 Population and Abundance

Global population abundance is estimated at more than 50,000, including about 35,000 in northern Davis Strait and Baffin Bay, 1,300 in Hudson Strait, and 300 in Scoresby Sound (Heide-Jorgensen 2009; Jefferson et al. 2008b). Recent estimates of abundance for the wintering grounds of west Greenland are of about 7,819 (Heide-Jorgensen 2009).

3.4.2.16.4 Predator/Prey Interactions

Narwhals feed mainly on fish and squid, but much depends on seasonal availability. A large part of their diet consists of medium to large fish, such as turbot and cod (Jefferson et al. 2008b). A recent study on stomach content analysis showed that in summer, their diet is mainly Arctic cod, polar cod, and squid (Heide-Jorgensen 2009). In fall, squid is the main source of prey, and in winter, Greenland halibut and squid are the main sources (Laidre and Heide-Jorgensen 2005; Laidre et al. 2003). This species uses suction to bring prey into the mouth.

Killer whales and polar bears are the only known predators of narwhals (Heide-Jorgensen 2009). Killer whales hunt them in the summer open-water season, and polar bears hunt them from sea ice in winter and spring (Heide-Jorgensen 2009).

3.4.2.16.5 Species-Specific Threats

There are no significant species-specific threats to narwhals in the northwest Atlantic, although climate change may be a concern because this species inhabits an extreme northern range. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.17 Beaked Whales (Various Species)

Based upon available data, six beaked whales are known in the western North Atlantic Ocean: Cuvier's beaked whale (*Ziphius cavirostris*), northern bottlenose whale (*Hyperoodon ampullatus*), and four members of the genus *Mesoplodon* —True’s (*M. mirus*), Gervais' (*M. europaeus*), Blainville's (*M. densirostris*), and Sowerby's (*M. bidens*) beaked whales, which, with the exception of *Ziphius* and *Hyperoodon*, are nearly indistinguishable at sea (Coles 2001). *Ziphius* and three species of *Mesoplodon* (Blainville's, Gervais', and Sowerby's) are known to occur in the Gulf of Mexico, based on stranding or sighting data (Hansen et al. 1995; Würsig et al. 2000). Sowerby’s beaked whale in the Gulf of Mexico is considered extralimital because there is only one known stranding of this species (Bonde and O'Shea 1989) and because it normally occurs in northern temperate waters of the North Atlantic (Mead 1989a). Because of the scarcity of biological information available for individual species, the difficulty of species-level identifications for *Mesoplodon* species, and the lack of data on individual stock structure and abundance estimates, *Ziphius* and *Mesoplodon* species are presented collectively here with species-specific information if available.

3.4.2.17.1 Status and Management

All beaked whales are protected under the MMPA but none are listed under the ESA. Stock structure in the Atlantic, Gulf of Mexico, and U.S. Virgin Islands is unknown; however, these are assumed to be separate for management purposes.

3.4.2.17.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

Collectively, beaked whales occur in all regions of the Study Area but may be most common in the Northeast and Southeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems. The continental shelf margins from Cape Hatteras to southern Nova Scotia were recently identified as known key areas for beaked whales in a global review by MacLeod and Mitchell (2006). MacLeod and Mitchell (2006) also described the northern Gulf of Mexico continental shelf margin as "a key area" for beaked whales. Beaked whales were seen in all seasons during GulfCet aerial surveys of the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico) (Hansen et al. 1996; Mullin and Hoggard 2000). Some of the aerial survey sightings may have included Cuvier's beaked whale, but identification of beaked whale species from aerial surveys is problematic. Beaked whale sightings made during spring and summer vessel surveys were widely distributed in waters greater than 500 m deep.

Cuvier's beaked whale is one of the more commonly seen and the best known. Similar to other beaked whale species, this oceanic species generally occurs in waters past the edge of the continental shelf and occupies almost all temperate, subtropical, and tropical waters of the world, as well as subpolar and even polar waters in some areas. The distribution of Cuvier's beaked whales is poorly known, and is based mainly on stranding records (Leatherwood et al. 1976). Strandings were reported from Nova Scotia along the eastern U.S. coast south to Florida, around the Gulf of Mexico, and within the Caribbean (Cetacean and Turtle Assessment Program 1982; Heyning 1989; Houston 1990; Leatherwood et al. 1976; MacLeod 2006; Mignucci-Giannoni et al. 1999). Cuvier's beaked whale sightings have occurred principally along the continental shelf edge in the mid-Atlantic region off the northeast U.S. coast (Cetacean and Turtle Assessment Program 1982; Hamazaki 2002; Palka 2006; Waring et al. 1992; Waring et al. 2001) in late spring or summer, although strandings and sightings were reported in the Caribbean Sea and the Gulf of Mexico as well (Dalebout et al. 2006). 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 (Falcone et al. 2009; Jefferson et al. 2008b).

True's beaked whales appear to occur only in temperate waters, and possibly only in warm temperate waters. Most records of it occurring in the northwest Atlantic suggest a probable relation with the Gulf Stream (MacLeod 2000; Mead 1989b).

Gervais' beaked whale occurs only in the Atlantic Ocean and Gulf of Mexico, within a range both north and south of the equator to a latitude of 40° (Jefferson et al. 2008b; MacLeod 2006). Although the distribution seems to range across the entire temperate and tropical Atlantic, most records are from the western North Atlantic waters from New York to Texas (more than 40 published records).

Sowerby's beaked whales appear to inhabit more temperate waters than many other members of the genus and are the most northerly distributed of Atlantic species of *Mesoplodon*, found in cold temperate waters of the North Atlantic Ocean, generally north of 30˚ N. In the Study Area, they range from Massachusetts to Labrador (MacLeod et al. 2006; Mead 1989a). There were several at-sea sightings off Nova Scotia and Newfoundland, from New England waters north to the ice pack (MacLeod et al. 2006; Waring et al. 2010). Sowerby's beaked whale may be found within the Northeast U.S. Continental Shelf, Newfoundland-Labrador Shelf, and Scotian Shelf Large Marine Ecosystems as well as the Labrador Current Open Ocean Area.

Blainville's beaked whales are one of the most widely distributed of the distinctive toothed whales in the *Mesoplodon* genus (Jefferson et al. 2008b; MacLeod et al. 2006). In the Study Area, this species is known to occur in enclosed deepwater seas, such as the Gulf of Mexico and Caribbean Sea. There are records for this species from the eastern coast of the United States and Canada, from as far north as Nova Scotia (Northeastern U.S. Continental Shelf and Newfoundland-Labrador Shelf Large Marine Ecosystems), and south to Florida and the Bahamas within the Southeastern U.S. Continental Shelf Large Marine Ecosystem (MacLeod and Mitchell 2006; Mead 1989a).

3.4.2.17.3 Population and Abundance (Excerpts from Waring et al. (2013))

Estimates of the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) from selected regions are available for select time periods (Barlow et al. 2006) as well as one estimate alone of each Cuvier's beaked whales, Gervais' beaked whales, and Sowerby's beaked whales. Sightings are almost exclusively in the continental shelf edge and continental slope areas. The total number of Blainville's and True's beaked whales off the eastern U.S. and Canadian Atlantic coasts are unknown, and seasonal abundance estimates are not available for these stocks. The best abundance estimates for Northwest Atlantic beaked whale stocks are as follows: Cuvier's beaked whales - 4,962 (CV=0.37) with a minimum population estimate of 3,670; Gervais' beaked whales - 1,847 (CV=0.96) with a minimum of 935; Sowerby's beaked whales - 3,653 (CV=0.69) with a minimum of 2,160.

The best abundance estimate available for Cuvier's beaked whales in the northern Gulf of Mexico is 74 (CV=1.04). This estimate is from a summer 2009 oceanic survey covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone. However, this abundance estimate is negatively biased because only sightings of beaked whales that could be positively identified to species were used. The minimum population estimate for the northern Gulf of Mexico is 36 Cuvier's beaked whales. The total number of Blainville's and Gervais' beaked whales in the northern Gulf of Mexico is unknown. The best available abundance estimate is for *Mesoplodon* spp., and is a combined estimate for Blainville's beaked whale and Gervais' beaked whale. The estimate of abundance for *Mesoplodon* spp. in oceanic waters, using data from a summer 2009 oceanic survey, is 149 (CV=0.91).

3.4.2.17.4 Predator/Prey Interactions

Beaked whales are generally deepwater feeders and prey on both squid and fish. Examination of stomach contents from stranded *Mesoplodon* species indicates that they feed primarily on deep-water cephalopods (MacLeod et al. 2003). Stomach content analyses of captured and stranded *Mesoplodon* species suggest that beaked whales are deep divers that feed at or close to the bottom in deep oceanic waters, taking whatever suitable prey they encounter or feeding on whatever species are locally abundant (Ohizumi 2002). Stomach content analyses from Cuvier's beaked whales show that they feed mostly on deep-sea squid, fish, and crustaceans (Hickmott 2005; Santos et al. 2007). Data show that Cuvier's beaked whales use suction to ingest prey (Jefferson et al. 2008b; Werth 2006).

3.4.2.17.5 Species-Specific Threats

Impacts from anthropogenic noise have become a serious concern with regard to beaked whales over the past decade. Section 3.4.3.1.2.7 (Stranding) summarizes several stranding events that have been associated with the use of naval sonar. In addition, disturbance by anthropogenic noise may prove to be an important habitat issue in some areas of beaked whales' range, notably in areas of concentrated military activity, oil and gas activity, or shipping. Ongoing studies are currently being conducted to address this issue and its impact, if any, on this and other marine species.

3.4.2.18 Northern Bottlenose Whale (*Hyperoodon ampullatus*)

3.4.2.18.1 Status and Management

The northern bottlenose whale is not listed under the ESA but is protected under the MMPA. There are two populations of northern bottlenose whales in the western north Atlantic: one in the area referred to as the Gully and a second in Davis Strait off northern Labrador. The Gully is a unique ecosystem that appears to have long provided a stable year-round habitat for a distinct population of bottlenose whales (Dalebout et al. 2006).

3.4.2.18.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

Northern bottlenose whales are distributed in the North Atlantic from Nova Scotia to about 70° in the Davis Strait, along the east coast of Greenland to 77°, and from England to the west coast of Spitzbergen. It is largely a deep-water species and is very seldom found in waters less than 2,000 m deep (Mead 1989b). There are two main centers of bottlenose whale distribution in the western North Atlantic, one in the area called the Gully just north of Sable Island, Nova Scotia, and the other in Davis Strait off northern Labrador (Reeves et al. 1993). The northern bottlenose whale occurs from New England to Baffin Island and to southern Greenland. Strandings as far south as North Carolina were observed, although that is outside of the natural range or at the edge of the southern range for this more subarctic species (Jefferson et al. 2008b; MacLeod et al. 2006).

3.4.2.18.3 Population and Abundance

Current estimates of abundance are around 40,000 in the eastern North Atlantic, but population estimates for this species along the eastern U.S. coast are unknown (Jefferson et al. 2008b; Palka 2006; Waring et al. 2010). Abundance estimates for the Gully population, derived from studies at the entrance to the Gully from 1988 to 1995, estimated the population to be around 230 (Waring et al. 2013). Wimmer and Whitehead (2004) observed individuals moving between several Scotian Shelf canyons more than 62 mi. (100 km) from the Gully and estimated a population of 163 (Waring et al. 2013; Wimmer and Whitehead 2004).

3.4.2.18.4 Predator/Prey Interactions

This species preys primarily on squid but will also take fishes, sea cucumbers, seastars, and prawns, as confirmed by stomach content analyses. They appear to be more benthic (bottom of the sea) feeders, foraging at depths of between 500 and 1,500 m (Hooker and Whitehead 2002; Jefferson et al. 2008b).

3.4.2.18.5 Species-Specific Threats

There are no significant species-specific threats to northern bottlenose whales in the northwest Atlantic. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.19 Rough-Toothed Dolphin (*Steno bredanensis*)

3.4.2.19.1 Status and Management

This species is not listed under the ESA but is protected under the MMPA. Rough-toothed dolphins are among the most widely distributed species of tropical dolphins, but little information is available on population status (Jefferson 2009; Jefferson et al. 2008b). The east U.S. Atlantic and Gulf of Mexico populations of the rough-toothed dolphin are considered two separate stocks for management purposes, but there is insufficient genetic information to differentiate these stocks (Waring et al. 2013; Wimmer and Whitehead 2004).

3.4.2.19.2 Population and Abundance (Excerpts from Waring et al. (2013))

The number of rough-toothed dolphins off the eastern United States and Canadian Atlantic coast is unknown, and seasonal abundance estimates are not available for this stock, since it was rarely seen during surveys. Three rough-toothed dolphins were observed from a ship in July 1998 during a line-transect sighting survey conducted from 6 July to 6 September 1998 by a ship and plane that surveyed 25,588.57 mi. (15,900 km) of track line in waters north of Maryland (38°N) (Palka 2006). An abundance estimate of 30 (CV=0.86) was calculated based on this one sighting. The current population size for the rough-toothed dolphin in the northern Gulf of Mexico is 624 (CV=0.991). This estimate is from a summer 2009 oceanic survey covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone. The minimum population estimate for northern Gulf of Mexico rough-toothed dolphins is 311.

3.4.2.19.3 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

The distribution of the rough-toothed dolphin is poorly understood worldwide. These dolphins are thought to be a tropical to warm-temperate species and historically have been reported in deep oceanic waters in the Atlantic, Pacific, and Indian Oceans and the Mediterranean and Caribbean Seas (Gannier and West 2005; Leatherwood and Reeves 1983; Perrin and Walker 1975; Reeves et al. 2003). Rough-toothed dolphins were, however, observed in both shelf and oceanic waters in the northern Gulf of Mexico (Fulling et al. 2003; Mullin and Fulling 2003). In the western North Atlantic, tracking of five rough-toothed dolphins that were rehabilitated and released following a mass stranding on the east coast of Florida in 2005 demonstrated a variety of ranging patterns (Wells et al. 2008b). All tagged rough-toothed dolphins moved through a large range of water depths averaging greater than 100 ft. (30 m), though each of the five tagged dolphins transited through very shallow waters at some point, with most of the collective movements recorded over a gently sloping sea floor.

3.4.2.19.4 Predator/Prey Interactions

Prey of rough-toothed dolphins includes fish and cephalopods. They are known to feed on large fishes such as mahi mahi (Miyazaki and Perrin 1994; Pitman and Stinchcomb 2002). They also prey on reef fish, and Perkins and Miller (1983) noted that parts of reef fish were found in the stomachs of stranded rough-toothed dolphins in Hawaii. Rough-toothed dolphins also feed during the day on near-surface fishes, including flying fishes (Gannier and West 2005).

Rough-toothed dolphins have not been documented to be preyed on by any other species, but they may be subject to predation by killer whales.

3.4.2.19.5 Species-Specific Threats

There are no significant species-specific threats to rough-toothed dolphins in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.20 Bottlenose Dolphin (*Tursiops truncatus*)

3.4.2.20.1 Status and Management

This species is not listed under the ESA but is protected under the MMPA. Along the U.S. east coast and northern Gulf of Mexico, the bottlenose dolphin stock structure is well studied. There are currently

52 management stocks identified by NMFS in the western North Atlantic and Gulf of Mexico, including oceanic, coastal, and estuarine stocks (Waring et al. 2010). Most stocks in the Study Area are designated as Strategic or Depleted under the MMPA. For a complete listing of currently identified stocks within the Study Area, see Table 3.4-1.

3.4.2.20.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

The bottlenose dolphin occurs in tropical to temperate waters of the Atlantic Ocean as well as inshore, nearshore, and offshore waters of the Gulf of Mexico and U.S. east coast. They generally do not range north or south of 45° latitude (Jefferson et al. 2008b; Wells and Scott 2008). They occur in most enclosed or semi-enclosed seas in habitats ranging from shallow, murky, estuarine waters to also deep, clear offshore waters in oceanic regions (Jefferson et al. 2008b; Wells et al. 2009). Bottlenose dolphins are also often found in bays, lagoons, channels, and river mouths and are known to occur in very deep waters of some ocean regions. Open ocean populations occur far from land; however, population density appears to be highest in nearshore areas (Scott and Chivers 1990).

There are two morphologically and genetically distinct bottlenose dolphin morphotypes (distinguished by physical differences) (Duffield 1987; Duffield et al. 1983) described as the coastal and offshore forms. Both inhabit waters in the western North Atlantic Ocean and Gulf of Mexico (Curry and Smith 1997; Hersh and Duffield 1990; Mead and Potter 1995) along the U.S. Atlantic coast. The coastal morphotype of bottlenose dolphin is continuously distributed along the Atlantic coast south of Long Island, New York, around the Florida peninsula, and along the Gulf of Mexico coast. North of Cape Hatteras, the two morphotypes are separated across bathymetry during summer months. Aerial surveys flown during 1979–1981 indicated a concentration of bottlenose dolphins in waters less than 25 m deep corresponding to the coastal morphotype, and an area of high abundance along the shelf break corresponding to the offshore stock (Cetacean and Turtle Assessment Program 1982; Kenney 1990). However, during winter months and south of Cape Hatteras, North Carolina, the ranges of the coastal and offshore morphotypes overlap to some degree.

Seasonally, bottlenose dolphins occur over the outer continental shelf and inner slope as far north as Georges Bank (Cetacean and Turtle Assessment Program 1982; Kenney 1990). Sightings occurred along the continental shelf break from Georges Bank to Cape Hatteras during spring and summer (Cetacean and Turtle Assessment Program 1982; Kenney 1990). In Canadian waters, bottlenose dolphins were occasionally sighted on the Scotian Shelf, particularly in the Gully (Gowans and Whitehead 1995). The range of the offshore bottlenose dolphin includes waters beyond the continental slope (Kenney 1990), and offshore bottlenose dolphins may move between the Gulf of Mexico and the Atlantic (Wells et al. 1999). Dolphins with characteristics of the offshore type have stranded as far south as the Florida Keys.

Initially, a single stock of coastal morphotype bottlenose dolphins was thought to migrate seasonally between New Jersey (summer months) and central Florida based on seasonal patterns in strandings during a large scale mortality event occurring during 1987–1988 (Scott et al. 1988). However, reanalysis of stranding data (McLellan et al. 2002) and extensive analysis of genetic (Rosel et al. 2009), photo-identification (Zolman 2002), and satellite telemetry (Southeast Fisheries Science Center, unpublished data) data demonstrate a complex mosaic of coastal bottlenose dolphin stocks. Integrated analysis of these multiple lines of evidence suggests that there are five coastal stocks of bottlenose dolphins: the Northern Migratory stock, Southern Migratory stock, a South Carolina/Georgia Coastal stock, a Northern Florida Coastal stock, and a Central Florida Coastal stock (Waring et al. 2013). Similarly, five coastal or open ocean stocks are identified in the Gulf of Mexico: Continental Shelf, eastern coastal, northern coastal, western coastal, and oceanic (Waring et al. 2013).

Several lines of evidence support a distinction between dolphins inhabiting coastal waters near the shore and those present primarily in the inshore waters of the bays, sounds, and estuaries. Photo-identification and genetic studies support the existence of resident estuarine animals in several areas (Caldwell 2001; Gubbins 2002; Gubbins et al. 2003; Litz 2007; Mazzoil et al. 2005; Zolman 2002), and similar patterns were observed in bays and estuaries along the Gulf of Mexico coast (Balmer et al. 2008; Wells et al. 1987). There are over 40 individual stocks resident in bays, sounds, and estuaries from North Carolina through the Gulf of Mexico, with 32 recognized in the Gulf of Mexico alone, although the structure of these stocks is uncertain but appears to be complex.

3.4.2.20.3 Population and Abundance

Although abundance is not estimated for all stocks that occur in U.S. Atlantic and Gulf of Mexico waters, there are estimated to be over 100,000 individuals in the U.S. Atlantic and 35,000–45,000 in the Gulf of Mexico (Waring et al. 2013). Current estimates used by NMFS for management are summarized in Table 3.4-1.

3.4.2.20.4 Predator/Prey Interactions

Bottlenose dolphins are opportunistic feeders, taking a variety of fishes, cephalopods, and crustaceans (Wells and Scott 1999) and using a variety of feeding strategies (Shane et al. 1986). In addition to using echolocation, a process for locating prey by emitting sound waves that reflect back, bottlenose dolphins likely detect and orient to fish prey by listening for the sounds they produce, so-called passive listening (Barros and Myrberg 1987; Barros and Wells 1998). Nearshore bottlenose dolphins prey predominantly on coastal fishes and cephalopods, while offshore individuals prey on open ocean cephalopods and a large variety of near-surface and mid-water fishes (Mead and Potter 1995).

This species is known to be preyed on by killer whales and sharks (Wells and Scott 1999). As many as half the observed bottlenose dolphin in Florida exhibit scars from shark attacks. Primary shark predators are considered to be the bull, tiger, great white, and dusky sharks (Wells and Scott 1999).

3.4.2.20.5 Species-Specific Threats

There are no significant species-specific threats to bottlenose dolphins in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.21 Pantropical Spotted Dolphin (*Stenella attenuata*)

3.4.2.21.1 Status and Management

This species is not listed under the ESA but is protected under the MMPA. The western North Atlantic and northern Gulf of Mexico populations are considered separate stocks for management purposes, although there is currently not enough information to distinguish them (Waring et al. 2013).

3.4.2.21.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

The pantropical spotted dolphin is distributed in offshore tropical and subtropical waters of the Atlantic Ocean between about 40° N and 40° S (Baldwin et al. 1999; Perrin 2008c). 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). Most sightings of this species in the Gulf of Mexico and Caribbean occur over the lower continental slope (Mignucci-Giannoni et al. 2003; Moreno et al. 2005). Pantropical spotted dolphins in the offshore Gulf of Mexico do not appear to have a preference for any one specific habitat type, such as within the Loop Current, inside cold-core eddies, or along the continental slope (Baumgartner et al. 2001).

Northeast and Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems. The pantropical spotted dolphin is the most commonly sighted species of cetacean in the oceanic waters of the northern Gulf of Mexico. Pantropical spotted dolphins were seen in all seasons during GulfCet aerial surveys of the northern Gulf of Mexico between 1992 and 1998 (Hansen et al. 1996; Mullin and Hoggard 2000). Along the U.S. Atlantic coast, sightings have concentrated in the slope waters north of Cape Hatteras, but in the shelf waters south of Cape Hatteras sightings extend into the deeper slope and offshore waters of the mid-Atlantic.

3.4.2.21.3 Population and Abundance (Excerpts from Waring et al. (2013))

The best recent abundance estimate for western North Atlantic stock of pantropical spotted dolphins is 4,439 (CV=0.49). This is the sum of estimates from two 2004 western U.S. Atlantic surveys and is considered best because these two surveys together have the most complete coverage of the species' habitat. The minimum population estimate for this stock is 3,010.

The best abundance estimate available for northern Gulf of Mexico pantropical spotted dolphins is 34,067 (CV=0.18) (Mullin 2007). This estimate is pooled from summer 2003 and spring 2004 oceanic surveys covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone.

3.4.2.21.4 Predator/Prey Interactions

Pantropical spotted dolphins prey on near-surface fishes, squid, and crustaceans and on some mid-water species (Perrin and Hohn 1994). Results from various tracking and food habit 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 after dark with the deep scattering layer (stratified zones in the ocean, usually composed of marine organisms that migrate vertically from depth to surface and back again at different times of day) (Baird et al. 2001; Evans 1994; Robertson and Chivers 1997).

Pantropical spotted dolphins may be preyed on by killer whales and sharks and were observed fleeing killer whales in Hawaiian waters (Baird et al. 2006). Other predators may include the pygmy killer whale, false killer whale, and occasionally the short-finned pilot whale (Perrin 2008c).

3.4.2.21.5 Species-Specific Threats

There are no significant species-specific threats to pantropical spotted dolphins in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.22 Atlantic Spotted Dolphin (*Stenella frontalis*)

3.4.2.22.1 Status and Management (Excerpts from Waring et al. (2013))

The Atlantic spotted dolphin is not listed under the ESA but is protected under the MMPA. The Atlantic spotted dolphin occurs in two forms that may be distinct subspecies (Perrin et al. 1994a; Perrin et al. 1987; Rice 1998): the large, heavily spotted form, which inhabits the continental shelf and is usually found inside or near the 200-m isobath; and the smaller, less spotted island and offshore form, which occurs in the Atlantic Ocean but is not known to occur in the Gulf of Mexico (Fulling et al. 2003; Mullin and Fulling 2003, 2004). The western North Atlantic population is provisionally being considered a separate stock from the Gulf of Mexico stock(s) for management purposes based on genetic analysis. The U.S. Virgin Islands population is provisionally being considered a separate stock, although there is currently no information to differentiate this stock from the Atlantic Ocean and Gulf of Mexico stocks.

3.4.2.22.2 Habitat and Geographic Range

The Atlantic spotted dolphin is found in nearshore tropical to warm-temperate waters, predominantly over the continental shelf and upper slope. In the eastern Gulf of Mexico, for instance, the species often occurs over the mid-shelf (Griffin and Griffin 2003). In the western Atlantic, this species is distributed from New England to Brazil and is found in the Gulf of Mexico as well as the Caribbean Sea (Perrin 2008a). Atlantic spotted dolphin sightings have been concentrated in the slope waters north of Cape Hatteras, but in the shelf waters south of Cape Hatteras sightings extend into the deeper slope and offshore waters of the mid-Atlantic.

In the Study Area, this species' primary range extends into the Gulf Stream Open Ocean Area and throughout the Southeast Continental U.S. Shelf, Gulf of Mexico, and Caribbean Sea Large Marine Ecosystems (Fulling et al. 2003; Mullin and Fulling 2003, 2004; Roden and Mullin 2000). The large, heavily spotted coastal form of the Atlantic spotted dolphin typically occurs over the continental shelf but usually at least 4.9 to 12.4 mi. (8 to 20 km) offshore (Davis et al. 1998; Perrin 2002; Perrin et al. 1994a). Higher numbers of spotted dolphins are reported over the west Florida continental shelf (Southeast Continental Shelf Large Marine Ecosystem) from November to May than during the rest of the year, suggesting that this species may migrate seasonally (Griffin and Griffin 2003).

3.4.2.22.3 Population and Abundance (Excerpts from Waring et al. (2013))

Because *S. frontalis* and *S. attenuata* are difficult to differentiate at sea, the reported abundance estimates, prior to 1998, are for both species of spotted dolphins combined. At their November 1999 meeting, the Atlantic Scientific Review Group recommended that without a genetic determination of stock structure, the abundance estimates for the coastal and offshore forms should be combined. There remains debate over how distinguishable both species are at sea, although in the waters south of Cape Hatteras identification to species is made with very high certainty. This does not, however, account for the potential for a mixed species herd, as has been recorded for several dolphin assemblages. Pending further genetic studies for clarification of this problem, a single species abundance estimate will be used as the best estimate of abundance, combining species-specific data from the northern as well as southern portions of the species' ranges. The best recent abundance estimate for western North Atlantic stock of Atlantic spotted dolphins is 26,798 (CV=0.66). The minimum population estimate based on the 2011 abundance estimates is 16,151.

The current population size for the Atlantic spotted dolphin in the northern Gulf of Mexico is unknown because the survey data from the continental shelf that covers the majority of this stock's range are more than eight years old (Wade and Angliss 1997). However, the previous abundance estimate for the Atlantic spotted dolphin in the northern Gulf of Mexico was 37,611 (CV=0.28), based on combined estimates of abundance for both the outer continental shelf (fall surveys, 2000–2001) and oceanic waters (spring and summer surveys, 2003–2004).

The abundance of the Puerto Rico and U.S. Virgin Islands stock of Atlantic spotted dolphins is unknown.

3.4.2.22.4 Predator/Prey Interactions

Atlantic spotted dolphins feed on small cephalopods, fishes, and benthic invertebrates (Perrin et al. 1994a). Atlantic spotted dolphins in the Gulf of Mexico were observed feeding cooperatively on clupeid fishes and are known to feed in association with shrimp trawlers (Fertl and Leatherwood 1997; Fertl and Wursig 1995). In the Bahamas, this species was observed to chase and catch flying fish (MacLeod et al.

2004). The diet of the Atlantic spotted dolphin varies depending on its location (Jefferson et al. 2008b; Perrin et al. 1994a).

This species was documented to be prey for killer whales and sharks (Jefferson et al. 2008b; Perrin et al. 1994a).

3.4.2.22.5 Species-Specific Threats

There are no significant species-specific threats to Atlantic spotted dolphins in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.23 Spinner Dolphin (*Stenella longirostris*)

3.4.2.23.1 Status and Management

The spinner dolphin is protected under the MMPA but is not listed under the ESA. For management purposes, the western North Atlantic and Gulf of Mexico populations are considered separate stocks, although there is currently insufficient data to differentiate them (Waring et al. 2013).

3.4.2.23.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

This is presumably an offshore, deep-water species (Perrin and Gilpatrick 1994; Schmidly 1981), and its distribution in the Atlantic is very poorly known. In the western North Atlantic, these dolphins occur in deep water along most of the U.S. coast south to the West Indies and Venezuela, including the Gulf of Mexico. Spinner dolphin sightings have occurred exclusively in deeper (greater than 2,000 m) oceanic waters of the northeast U.S. coast (Cetacean and Turtle Assessment Program 1982; Waring et al. 1992). Stranding records exist from North Carolina, South Carolina, Florida, and Puerto Rico in the Atlantic and in Texas and Florida in the Gulf of Mexico. In the Study Area, the open ocean range of the spinner dolphin includes the southern portions of the Gulf Stream and North Atlantic Gyre as well as Caribbean Sea and Gulf of Mexico. Although spinner dolphins were sighted and stranded off the southeastern U.S. coast, they are not common in those waters, except perhaps off southern Florida (Waring et al. 2010).

Gulf of Mexico Large Marine Ecosystem. In the northern Gulf of Mexico, spinner dolphins are found mostly in offshore waters beyond the edge of the continental shelf (Waring et al. 2013). This species was seen during all seasons in the northern Gulf of Mexico during aerial surveys between 1992 and 1998 (Waring et al. 2013).

3.4.2.23.3 Population and Abundance

There is insufficient data to calculate an abundance estimate for the western North Atlantic stock of spinner dolphins (Waring et al. 2013). The best abundance estimate available for northern Gulf of Mexico spinner dolphins is 11,441 (CV=0.83). This estimate is from a summer 2009 oceanic survey covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone. The minimum population estimate for the northern Gulf of Mexico is 6,221 spinner dolphins (Waring et al. 2013).

3.4.2.23.4 Predator/Prey Interactions

Spinner dolphins feed primarily on small mid-water fishes, squids, and shrimp and they dive to at least 655 to 985 ft. (200 to 300 m) (Perrin and Gilpatrick 1994). They forage primarily at night, when the mid-water community migrates toward the surface and the shore (Benoit-Bird 2004; Benoit-Bird et al. 2001).

Spinner dolphins track the horizontal migrations of their prey (Benoit-Bird and Au 2003), allowing foraging efficiencies (Benoit-Bird 2004; Benoit-Bird and Au 2003). Foraging behavior was also linked to lunar phases in scattering layers off the island of Hawaii (Benoit-Bird and Au 2004).

Spinner dolphins may be preyed on by sharks, killer whales, pygmy killer whales, and short-finned pilot whales (Perrin 2008d).

3.4.2.23.5 Species-Specific Threats

There are no significant species-specific threats to spinner dolphins in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.24 Clymene Dolphin (*Stenella clymene*)

3.4.2.24.1 Status and Management

The species is not listed under the ESA but is protected under the MMPA. The clymene dolphin has an extensive range in the tropical Atlantic Ocean. There are insufficient data to determine the population trends for this species (Waring et al. 2010).

3.4.2.24.2 Habitat and Geographic Range

Clymene dolphins are a tropical to subtropical species, primarily sighted in deep waters well beyond the edge of the continental shelf (Fertl et al. 2003). In the western North Atlantic, clymene dolphins were observed as far north as New Jersey, although sightings were primarily in offshore waters east of Cape Hatteras over the continental slope and are likely to be strongly influenced by oceanographic features of the Gulf Stream (Fertl et al. 2003; Moreno et al. 2005; Mullin and Fulling 2003). Clymene dolphins in the Gulf of Mexico are observed most frequently on the lower slope and deepwater areas, primarily west of the Mississippi River, in regions of cyclonic or confluent circulation (Davis et al. 2002; Mullin et al. 1994a). Clymene dolphins were seen in the winter, spring and summer during GulfCet aerial surveys of the northern Gulf of Mexico during 1992 to 1998 (Hansen et al. 1996; Mullin and Hoggard 2000).

3.4.2.24.3 Population and Abundance

Data are insufficient to estimate abundance for the western North Atlantic stock. The best abundance estimate available for northern Gulf of Mexico clymene dolphins is 129 (CV=1.00). This estimate is from a summer 2009 oceanic survey covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone. The minimum population estimate for the northern Gulf of Mexico is 64 individuals (Waring et al. 2013).

3.4.2.24.4 Predator/Prey Interactions

Available information on feeding habits is very limited. This species preys on small fish and squid at moderate depths and feeds primarily at night (Fertl et al. 1997; Jefferson et al. 2008b; Perrin et al. 1981).

This species is possibly preyed on by killer whales and large sharks, as evidenced by scars observed on their bodies, although actual predation was not observed (Jefferson 2008; Jefferson et al. 2008b).

3.4.2.24.5 Species-Specific Threats

There are no significant species-specific threats to clymene dolphins in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.25 Striped Dolphin (*Stenella coeruleoalba*)

3.4.2.25.1 Status and Management

This species is not listed under the ESA but is protected under the MMPA. For management purposes, the Gulf of Mexico population is provisionally considered a separate stock, although there are not sufficient genetic data to differentiate the Gulf of Mexico stock from the western North Atlantic stock (Waring et al. 2010). There is very little information on stock structure in the western North Atlantic and insufficient data to assess population trends of this species (Waring et al. 2010).

3.4.2.25.2 Habitat and Geographic Range (Excerpts from Waring et al. (2010))

The striped dolphin is one of the most common and abundant dolphin species, with a worldwide range that includes both tropical and temperate waters.

Although primarily a warm-water species, the range of the striped dolphin extends higher into temperate regions than those of any other species in the genus *Stenella* (spotted, spinner, clymene, and striped dolphins); it is found in the western North Atlantic from Nova Scotia south to at least Jamaica as well as in the Gulf of Mexico. In general, striped dolphins appear to prefer continental slope waters offshore to the Gulf Stream (Leatherwood et al. 1976; Perrin et al. 1994c; Schmidly 1981).

Gulf Stream Open Ocean Area. Striped dolphins are relatively common in the cooler offshore waters of the U.S. east coast. Along the mid-Atlantic ridge in oceanic waters of the North Atlantic Ocean, striped dolphins are sighted in significant numbers south of 50° N (Waring et al. 2010). In waters off the northeastern U.S. coast, striped dolphins are distributed along the continental shelf edge from Cape Hatteras to the southern margin of Georges Bank and also occur offshore over the continental slope and rise in the mid-Atlantic region (Cetacean and Turtle Assessment Program 1982; Mullin and Fulling 2003). Continental shelf edge sightings in the Cetacean and Turtle Assessment Program (1982) were generally centered along the 1,000-m depth contour in all seasons. During 1990 and 1991 cetacean habitat-use surveys, striped dolphins were associated with the Gulf Stream north wall and warm-core ring features (Waring et al. 1992). Striped dolphins seen in a survey of the New England Sea Mounts (Palka 1997) were in waters that were between 20° and 27°C and deeper than about 3,000 ft. (900 m).

Gulf of Mexico Large Marine Ecosystem. Striped dolphins are also found throughout the deep, offshore waters of the northern Gulf of Mexico. Sightings of striped dolphins in the northern Gulf of Mexico typically occur in oceanic waters and during all seasons (Waring et al. 2010).

3.4.2.25.3 Population and Abundance

The total number of striped dolphins off the U.S. or Canadian Atlantic coasts is unknown, although several estimates from selected regions are available for select time periods. Sightings are almost exclusively in the continental shelf edge and continental slope areas west of Georges Bank. The best abundance estimate for striped dolphins is 46,882 (CV=0.33) based on a 2011 survey (Palka 2012). The minimum population estimate for the western North Atlantic striped dolphin is 35,763 (Waring et al. 2013).

The best abundance estimate available for northern Gulf of Mexico striped dolphins is 3,325 (CV=0.48) (Mullin 2007). This estimate is pooled from summer 2003 and spring 2004 oceanic surveys covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone (Waring et al. 2013).

3.4.2.25.4 Predator/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 655 to 2,295 ft. (200 to 700 m) (Archer and Perrin 1999). Striped dolphins may feed at night 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. 1994c).

This species was documented to be preyed on by sharks (Ross 1971). It may also be subject to predation by killer whales.

3.4.2.25.5 Species-Specific Threats

There are no significant species-specific threats to striped dolphins in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.26 Fraser's Dolphin (*Lagenodelphis hosei*)

3.4.2.26.1 Status and Management

This species is not listed under the ESA but is protected under the MMPA. The Gulf of Mexico population is provisionally being considered a separate stock for management purposes, although there are no genetic data to differentiate this stock from the western North Atlantic stock.

3.4.2.26.2 Habitat and Geographic Range

Fraser's dolphin is a tropical, oceanic species, except where deep water approaches the coast (Dolar 2008). This species is assumed to occur in the tropical western North Atlantic, although only a single sighting of approximately 250 individuals was recorded in waters 3,300 m deep in the waters off Cape Hatteras during a 1999 vessel survey (National Marine Fisheries Service 1999).

Gulf of Mexico Large Marine Ecosystem. The first record for the Gulf of Mexico was a mass stranding in the Florida Keys in 1981 (Hersh and Odell 1986; Leatherwood et al. 1993). Since then, there have been documented strandings on the west coast of Florida and in southern Texas (Yoshida et al. 2010). Sightings of Fraser's dolphin in the northern Gulf of Mexico typically occur in oceanic waters greater than 656.2 ft. (200 m). This species was observed in the northern Gulf of Mexico during all seasons.

3.4.2.26.3 Population and Abundance

Current data are insufficient to calculate a population estimate for the western North Atlantic and Gulf of Mexico oceanic stocks of Fraser's dolphins (Waring et al. 2013).

3.4.2.26.4 Predator/Prey Interactions

Fraser's dolphin feeds on mid-water fishes, squids, and shrimps and has not been documented to be prey to any other species (Jefferson and Leatherwood 1994; Perrin et al. 1994b). However, this species may be subject to predation by killer whales.

3.4.2.26.5 Species-Specific Threats

There are no significant species-specific threats to Fraser's dolphins in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats To Marine Mammals) discusses threats to marine mammals.

3.4.2.27 Risso's Dolphin (*Grampus griseus*)

3.4.2.27.1 Status and Management

Risso's dolphin is not listed under the ESA but is protected under the MMPA. Risso's dolphins in the Atlantic Ocean are separated into the Gulf of Mexico and the North Atlantic stocks (Waring et al. 2010).

3.4.2.27.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

Risso's dolphins are distributed worldwide in tropical and temperate waters along the continental shelf break and over the continental slope and outer continental shelf (Baumgartner 1997; Canadas et al. 2002; Cetacean and Turtle Assessment Program 1982; Davis et al. 1998; Green et al. 1992; Kruse et al. 1999; Mignucci-Giannoni 1998). Risso's dolphins were also found in association with submarine canyons (Mussi et al. 2004). In the northwest Atlantic, Risso's dolphins occur from Florida to eastern Newfoundland (Baird and Stacey 1991; Leatherwood et al. 1976).

Open Ocean. The range of the Risso's dolphin distribution in open-ocean waters of the North Atlantic is known to include the Gulf Stream and the southwestern portions of the North Atlantic Gyre.

Northeast U.S. and Southeast U.S. Continental Shelf Large Marine Ecosystems. Off the northeast U.S. coast, Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras northward to Georges Bank during spring, summer, and autumn (Cetacean and Turtle Assessment Program 1982; Payne et al. 1984). In winter, the range is in the mid-Atlantic Bight and extends outward into oceanic waters (Payne et al. 1984). In general, the population occupies the mid-Atlantic continental shelf edge year round and is rarely seen in the Gulf of Maine (Payne et al. 1984). During 1990, 1991 and 1993, spring/summer surveys conducted along the continental shelf edge and in deeper oceanic waters sighted Risso's dolphins associated with strong bathymetric features, Gulf Stream warm core rings, and the Gulf Stream north wall (Hamazaki 2002; Waring et al. 1992, 1993).

Gulf of Mexico Large Marine Ecosystem. Risso's dolphins in the northern Gulf of Mexico occur throughout oceanic waters but are concentrated in continental slope waters (Baumgartner 1997; Maze-Foley and Mullin 2006). Risso's dolphins were seen in all seasons during GulfCet aerial surveys of the northern Gulf of Mexico between 1992 and 1998 (Hansen et al. 1996; Mullin and Hoggard 2000).

3.4.2.27.3 Population and Abundance

Nine abundance estimates are available for Risso's dolphins from selected regions for select time periods. Sightings were almost exclusively in continental shelf edge and continental slope. The best abundance estimate for Risso's dolphins is 15,197 (CV=0.55) based on a 2011 survey (Palka 2012). The minimum population estimate for the western North Atlantic Risso's dolphin is 9,857 (Waring et al. 2013).

The best abundance estimate available for northern Gulf of Mexico Risso's dolphins is 2,442 (CV=0.57). This estimate is from a summer 2009 oceanic survey covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone. The minimum population estimate for the northern Gulf of Mexico is 1,563 individuals (Waring et al. 2013).

3.4.2.27.4 Predator/Prey Interactions

Cephalopods and crustaceans are the primary prey for the Risso's dolphins (Clarke 1996), which feed mainly at night (Baird 2008; Jefferson et al. 2008b).

This dolphin may be preyed on by both killer whales and sharks, although there is no documented report of predation by either species (Weller 2008).

3.4.2.27.5 Species-Specific Threats

There are no significant species-specific threats to Risso's dolphins in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.28 Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*)

3.4.2.28.1 Status and Management

The Atlantic white-sided dolphin is not listed under the ESA but is protected under the MMPA. Three stocks of the Atlantic white-sided dolphin in the western North Atlantic Ocean were suggested for conservation management: Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea (Palka et al. 1997; Waring et al. 2004). However, genetic analysis indicates that no definite stock structure exists. The species is considered abundant in the North Atlantic (Jefferson et al. 2008b; Waring et al. 2013).

3.4.2.28.2 Habitat and Geographic Range

This species is found primarily in cold temperate to subpolar continental shelf waters to the 328 ft. (100 m) depth contour (Cetacean and Turtle Assessment Program 1982; Mate et al. 1994; Selzer and Payne 1988). Occurrence of Atlantic white-sided dolphins in the northeastern United States probably reflects fluctuations in food availability as well as oceanographic conditions (Palka et al. 1997; Selzer and Payne 1988). Before the 1970s, Atlantic white-sided dolphins were found primarily offshore in waters over the continental slope; however, since then, they occur primarily in waters over the continental shelf, replacing white-beaked dolphins, which were previously sighted in the area. This shift may have been the result of an increase in sand lance and a decline in herring in continental shelf waters (Payne et al. 1990). Areas of feeding importance are around Cape Cod and on the northwest edge of Georges Bank, in an area defined as the Great South Channel-Jeffreys Ledge corridor (Cetacean and Turtle Assessment Program 1982; Palka et al. 1997). Selzer and Payne (1988) sighted white-sided dolphins more frequently in areas of high seafloor relief and where sea surface temperatures and salinities were low, although these environmental conditions might be only secondarily influencing dolphin distribution; seasonal variation in sea surface temperature and salinity and local nutrient upwelling in areas of high seafloor relief may affect preferred prey abundances, which in turn might affect dolphin distribution (Selzer and Payne 1988).

Newfoundland-Labrador Shelf and Scotian Shelf Large Marine Ecosystems. This species' open ocean range includes the Gulf Stream. Atlantic white-sided dolphins are common in waters of the continental slope from New England in the west, north to southern Greenland (Cipriano 2008; Jefferson et al. 2008b). Along the Canadian and U.S. Atlantic coast, this species is most common from Hudson Canyon north to the Gulf of Maine (Palka et al. 1997).

Northeast U.S. Continental Shelf Large Marine Ecosystem. From January to April, low numbers of white-sided dolphins may be found from Georges Bank to Jeffreys Ledge. Even lower numbers are found south of Georges Bank (Palka et al. 1997; Payne et al. 1990; Waring et al. 2004). From June through September, large numbers of white-sided dolphins are found from Georges Bank to the lower Bay of Fundy (Payne et al. 1990; Waring et al. 2004). During this time, strandings occur from New Brunswick to New York (Palka et al. 1997). From October to December, white-sided dolphins occur at intermediate densities from southern Georges Bank to the southern Gulf of Maine. Sightings occur year-round south of Georges Bank, particularly around Hudson Canyon, but in low densities (Cetacean and Turtle Assessment Program 1982; Palka 1997; Payne et al. 1990; Waring et al. 2004).

Southeast U.S. Continental Shelf Large Marine Ecosystem. A few strandings were collected on Virginia and North Carolina beaches, which appear to represent the southern edge of the range for this species (Cipriano 2008; Testaverde and Mead 1980).

3.4.2.28.3 Population and Abundance

This species is quite abundant throughout its range, with numbers estimated to be in the hundreds of thousands. The best available current abundance estimate for white-sided dolphins in the western North Atlantic stock is 48,819 (CV=0.61) based on a 2011 survey (Palka 2012). However, because of apparent changes in the seasonal distribution of this species, the best available abundance estimate may come from one of the non-summer abundance surveys to be conducted between 2011-2015 (Waring et al. 2013).

3.4.2.28.4 Predator/Prey Interactions

The stomach contents of Atlantic white-sided dolphins caught through fishing bycatch, as well as those stranded off of the coast of New England, have included at least 26 fish species and three cephalopod species. The most prominent species were the silver hake, spoonarm octopus, and haddock. There is seasonal variation in the diet; Atlantic herring was found in more dolphins during the summer than in winter (Craddock et al. 2009). This species is known to feed in association with other delphinid (dolphin-like) and large whale species (Jefferson et al. 2008b; Palka 1997).

This species was not documented to be prey for any other species (Jefferson et al. 2008b).

3.4.2.28.5 Species-Specific Threats

A review of 405 cases of marine mammal mortalities on Cape Cod and southeastern Massachusetts from 2000 to 2006 concluded that mass strandings were the main cause of mortality for 69 percent of Atlantic white-sided dolphins (Bogomolni et al. 2010).

3.4.2.29 White-Beaked Dolphin (*Lagenorhynchus albirostris*)

3.4.2.29.1 Status and Management

The white-beaked dolphin is not listed under the ESA but is protected under the MMPA. There are at least two separate stocks of the white-beaked dolphin in the North Atlantic: one in the eastern and another in the western North Atlantic. Abundance has declined in some areas, such as the Gulf of Maine, but this may be more closely related to habitat shifts than to direct changes in population size.

3.4.2.29.2 Habitat and Geographic Range

White-beaked dolphins are found in cold-temperate and subarctic waters of the North Atlantic. In the western North Atlantic Ocean, the white-beaked dolphin occurs throughout northern waters of the east coast of the United States and eastern Canada, from eastern Greenland through the Davis Strait and south to Massachusetts (Lien et al. 2001).

Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf Large Marine Ecosystems. Within the Study Area, white-beaked dolphins are concentrated in the western Gulf of Maine and around Cape Cod (Cetacean and Turtle Assessment Program 1982; Palka et al. 1997). Before the 1970s, these dolphins were found primarily in waters over the continental shelf of the Gulf of Maine and Georges Bank; since then, they occur mainly in waters over the continental slope and are replaced by large numbers of Atlantic white-sided dolphins (Katona et al. 1993; Palka et al. 1997; Sergeant et al. 1980). This habitat shift might be a result of an increase in sand lance and a decline in herring in continental shelf waters (Payne et al. 1990).

Sightings are common in nearshore waters of Newfoundland and Labrador (Lien et al. 2001). They also occur in the Gulf of St. Lawrence (Waring et al. 2010). During Cetacean and Turtle Assessment Program (1982) surveys, white-beaked dolphins were typically sighted in shallow coastal waters near Cape Cod and along Stellwagen Bank, with a bottom depth ranging from 43 to 2,454 ft. (13 to 748 m) (Palka et al. 1997).

3.4.2.29.3 Population and Abundance

The total number of white-beaked dolphins in U.S. and Canadian waters is unknown. The best and only recent abundance estimate for the western North Atlantic white-beaked dolphin is 2,003 (CV=0.94), an estimate derived from aerial survey data collected in August 2006. It is assumed this estimate is negatively biased because the survey only covered part of the species' habitat. The minimum population estimate for these white-beaked dolphins is 1,023 (Waring et al. 2013).

3.4.2.29.4 Predator/Prey Interactions

This species preys on small mid-water and schooling fish, such as herring and haddock, and squid and crustaceans (Jefferson et al. 2008b). Cooperative feeding was observed (Jefferson et al. 2008b).

The white-beaked dolphin is possibly preyed on by killer whales and sharks. Although no attacks were documented, groups of white-beaked dolphin were observed fleeing from killer whales (Kinze 2008).

3.4.2.29.5 Species-Specific Threats

There are no significant species-specific threats to white-beaked dolphins in the northwest Atlantic. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.30 Common Dolphin (*Delphinus delphis/capensis*)

Because of the relatively recent discovery that common dolphins represent two distinct species (short-beaked common dolphin and long-beaked common dolphin), rather than a single species as previously thought, much of the biological information for dolphins of the genus *Delphinus* cannot be reliably applied to one or the other, especially in regions where the two species overlap (Heyning and Perrin 1994).

3.4.2.30.1 Status and Management

Common dolphins are protected under the MMPA but not listed under the ESA. Only the short-beaked common dolphin has occurrence within the Study Area. A discrete population of long-beaked common dolphins is known from the east coast of South America in the western Atlantic (Jefferson et al. 2008b). A single stock of short-beaked common dolphins is found within the Study Area: the western North Atlantic stock (Jefferson et al. 2009; Waring et al. 2013).

3.4.2.30.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

In the North Atlantic, common dolphins occur over the continental shelf along the 100–2,000-m isobaths and over prominent underwater topography and east to the mid-Atlantic Ridge (29°W)

(Doksaeter et al. 2008; Waring et al. 2008). The species is less common south of Cape Hatteras, although schools were reported as far south as the Georgia/South Carolina border (32° N) (Jefferson et al. 2009).

Gulf Stream Open Ocean Area. There is a well-studied population of short-beaked common dolphins in the western North Atlantic, associated with the Gulf Stream (Jefferson et al. 2009). It occurs mainly in offshore waters, ranging from Florida/Georgia to the Canada maritime provinces (Waring et al. 2010).

Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf Large Marine Ecosystems. In waters off the northeastern U.S. coast, common dolphins are distributed along the continental slope and are associated with Gulf Stream features (Cetacean and Turtle Assessment Program 1982; Hamazaki 2002; Selzer and Payne 1988; Stone et al. 1992). They primarily occur from Cape Hatteras northeast to Georges Bank (35° to 42°N) during mid-January to May (Cetacean and Turtle Assessment Program 1982; Hain et al. 1981; Payne et al. 1984). Common dolphins move onto Georges Bank and the Scotian Shelf from mid-summer to autumn. Selzer and Payne (1988) reported very large aggregations (greater than 3,000 animals) on Georges Bank in autumn. Common dolphins are occasionally found in the Gulf of Maine (Selzer and Payne 1988). Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs during summer and autumn when water temperatures exceed 11°C (Gowans and Whitehead 1995; Sergeant et al. 1970).

3.4.2.30.3 Population and Abundance

The current best abundance estimate for common dolphins off the U.S. or Canadian Atlantic coasts is based on a 2011 survey of 67,191 (CV=0.29) (Palka 2012). The minimum population estimate for the western North Atlantic common dolphin is 52,893 (Waring et al. 2013).

3.4.2.30.4 Predator/Prey Interactions

Stomach contents of *Delphinus* from outside of the Study Area in California waters revealed 19 species of fish and two species of cephalopods; *Delphinus* feed primarily on organisms in the vertically migrating deep scattering layer. Diel (a 24-hour cycle that often involves a day and the adjoining night) fluctuations in vocal activity, with more vocal activity during late evening and early morning, appear to be linked to feeding in the deep scattering layer, which rises in this same time frame (Goold 2000). In the western North Atlantic, oceanic dolphins feed more on squid than those in more nearshore waters (Perrin 2008b).

Short-beaked common dolphins are known to be preyed on by killer whales (Visser 1999) and large sharks (Leatherwood et al. 1973), although little is known about the impact of this predation on populations.

3.4.2.30.5 Species-Specific Threats

There are no significant species-specific threats to common dolphins in the northwest Atlantic. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.31 Melon-Headed Whale (*Peponocephala electra*)

3.4.2.31.1 Status and Management

The melon-headed whale is not listed under the ESA but is protected under the MMPA. For management purposes, the western North Atlantic population and Gulf of Mexico population are considered separate stocks, although genetic data that differentiate these two stocks is lacking (Waring et al. 2010).

3.4.2.31.2 Habitat and Geographic Range

Melon-headed whales are found worldwide in tropical and subtropical waters. They are occasionally reported at higher latitudes, but these movements are considered to be beyond their typical range because the records indicate these movements occurred during incursions of warm water currents (Perryman et al. 1994). Melon-headed whales are most often found in offshore deep waters but sometimes move close to shore over the continental shelf. In the Study Area, this species was observed in deep waters of the Gulf of Mexico, well beyond the edge of the continental shelf and in waters over the abyssal plain, primarily west of Mobile Bay, Alabama (Davis and Fargion 1996; Mullin et al. 1994b; Waring et al. 2010). Sightings of melon-headed whales in the northern Gulf of Mexico were documented in all seasons during GulfCet aerial surveys 1992 and 1998 (Hansen et al. 1996; Mullin and Hoggard 2000). Sightings of whales from the Western North Atlantic stock are rare, but a group of 20 whales was sighted during surveys in 1999, and a group of 80 whales was sighted off Cape Hatteras, North Carolina, in 2002, in waters greater than 8,202 ft. (2,500 m) deep (Waring et al. 2013).

3.4.2.31.3 Population and Abundance

The abundance of melon-headed whales off the eastern United States and Canadian Atlantic coast is unknown because of the rarity of sightings during surveys (Waring et al. 2010). The best abundance estimate available for northern Gulf of Mexico melon-headed whale stock is 2,283 (CV=0.76) (Mullin 2007). This estimate is pooled from summer 2003 and spring 2004 oceanic surveys covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone (Waring et al. 2013).

3.4.2.31.4 Predator/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 forms found in waters up to 4,920 ft. (1,500 m) deep, suggesting that feeding takes place deep in the water column (Jefferson and Barros 1997).

Melon-headed whales are believed to be preyed on by killer whales and were observed fleeing from killer whales in Hawaiian waters (Baird et al. 2006).

3.4.2.31.5 Species-Specific Threats

There are no significant species-specific threats to melon-headed whales in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.32 Pygmy Killer Whale (*Feresa attenuata*)

3.4.2.32.1 Status and Management

The pygmy killer whale is not listed under the ESA but is protected under the MMPA. For management purposes, the Gulf of Mexico population is considered a separate stock although there is not yet sufficient genetic information to differentiate this stock from the western North Atlantic stocks (Waring et al. 2013).

3.4.2.32.2 Habitat and Geographic Range

Although the pygmy killer whale has an extensive global distribution, it is not known to occur in high densities in any region and is therefore probably one of the least abundant pantropical delphinids. The pygmy killer whale is generally an open ocean deepwater species (Davis et al. 2000; Würsig et al. 2000). This species has a worldwide distribution in tropical and subtropical oceans. Pygmy killer whales generally do not range poleward of 40° N or of 35° S (Donahue and Perryman 2008; Jefferson et al. 2008b).

North Atlantic Gyre and Gulfstream Open Ocean Areas. In the Study Area, this species occurs in the North Atlantic Gyre and the Gulfstream, although sightings are rare. Most observations outside the tropics are associated with strong, warm western boundary currents that effectively extend tropical conditions into higher latitudes (Ross and Leatherwood 1994).

Gulf of Mexico Large Marine Ecosystem. In the northern Gulf of Mexico, the pygmy killer whale is found primarily in deeper waters off the continental shelf and in waters over the abyssal plain (Davis et al. 2000; Würsig et al. 2000).

3.4.2.32.3 Population and Abundance

There are no available abundance estimates for the western North Atlantic stock of pygmy killer whales, and this species is relatively rare in the Gulf of Mexico. The best estimate available for northern Gulf of Mexico pygmy killer whales is 152 (CV=1.02). This estimate is from a summer 2009 oceanic survey covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone. The minimum population estimate for the northern Gulf of Mexico is 75 pygmy killer whales (Waring et al. 2013).

3.4.2.32.4 Predator/Prey Interactions

Pygmy killer whales feed predominantly on fish and squid. They are known to attack other dolphin species, apparently as prey, although this is not common (Jefferson et al. 2008b; Perryman and Foster 1980; Ross and Leatherwood 1994).

The pygmy killer whale has no documented predators (Weller 2008). It may be subject to predation by killer whales.

3.4.2.32.5 Species-Specific Threats

There are no significant species-specific threats to pygmy killer whales in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.33 False Killer Whale (*Pseudorca crassidens*)

3.4.2.33.1 Status and Management

The false killer whale is not listed under the ESA but is protected under the MMPA. Little is known of the status of most false killer whale populations around the world. While the species is not considered rare, few areas of high density are known. The population found in the Gulf of Mexico is considered a separate stock for management purposes; however, there are no genetic data to differentiate this stock from the western North Atlantic stock.

3.4.2.33.2 Habitat and Geographic Range

False killer whales occur worldwide throughout warm temperate and tropical oceans in deep open-ocean waters and around oceanic islands and only rarely come into shallow coastal waters (Baird et al. 2008; Leatherwood and Reeves 1983; Odell and McClune 1999). Occasional inshore movements are associated with movements of prey and shoreward flooding of warm ocean currents (Stacey et al. 1994). In the Study Area, this species occurs rarely in the southwestern regions of the North Atlantic Gyre. Sightings of this species in the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico) occur in oceanic waters, primarily in the eastern Gulf (Maze-Foley and Mullin 2006; Mullin and Fulling 2004). False killer whales were seen only in the spring and summer during GulfCet aerial surveys of the northern Gulf of Mexico between 1992 and 1998 (Hansen et al. 1996; Mullin and Hoggard 2000) and in the spring during vessel surveys (Mullin et al. 2004).

3.4.2.33.3 Population and Abundance

The current population size for the false killer whale in the northern Gulf of Mexico is unknown because the survey data are more than eight years old (Waring et al. 2013). However, the previous best abundance estimate available for northern Gulf of Mexico false killer whales is 777 (CV=0.56) (Mullin 2007). This estimate is pooled from summer 2003 and spring 2004 oceanic surveys covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone (Waring et al. 2010).

3.4.2.33.4 Predator/Prey Interactions

False killer whales feed primarily on deep-sea cephalopods and fish (Odell and McClune 1999). They may prefer large fish species, such as mahi mahi and tuna. Twenty-five false killer whales that stranded off the coast of the Strait of Magellan (outside of the Study Area) were examined and found to feed primarily on cephalopods and fish. Squid beaks were found in nearly half of the stranded animals. The most important prey species were found to be squid, followed by Patagonian grenadier, a coastal fish (Alonso et al. 1999).

False killer whales were observed attacking 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. 2010).

This species is believed to be preyed on by large sharks and killer whales (Baird 2009b).

3.4.2.33.5 Species-Specific Threats

There are no significant species-specific threats to false killer whales in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.34 Killer Whale (*Orcinus orca*)

3.4.2.34.1 Status and Management

The killer whales in the Atlantic and Gulf of Mexico are not listed under the ESA although, like all marine mammals, they are protected under the MMPA. Although some populations, particularly in the northwest Pacific, are extremely well studied, little is known about killer whale populations in most areas including the northwest Atlantic. Killer whales are apparently not highly abundant anywhere but are observed in higher concentration in Antarctic waters. For management purposes, the western North Atlantic population and Gulf of Mexico population are considered separate stocks (Waring et al. 2010).

3.4.2.34.2 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 generally most numerous in coastal waters and at higher latitudes (Dahlheim and Heyning 1999).

Open Ocean. The open ocean range of the killer whale in the Study Area includes the Labrador Current, Gulf Stream, and North Atlantic Gyre.

Northeast and Southeast Large Marine Ecosystems. Killer whales are considered rare and uncommon in waters of the U.S. Exclusive Economic Zone in the Atlantic Ocean (Katona et al. 1988; Waring et al. 2010). During the 1978 to 1981 Cetacean and Turtle Assessment Program surveys, there were 12 killer whale sightings, which made up 0.1 percent of the 11,156 cetacean sightings in the surveys (Cetacean and Turtle Assessment Program 1982; Waring et al. 2010).

Nearshore observations are rare. Forty animals were observed in the southern Gulf of Maine in September 1979 and 29 animals in Massachusetts Bay in August 1986 (Katona et al. 1988; Waring et al. 2010).

Gulf of Mexico Large Marine Ecosystem. Sightings of killer whales in the Gulf of Mexico on surveys from 1951 to 1995 were in waters ranging from 840 to 8,700 ft. (256 to 2,652 m), with an average of 4,075 ft. (1,242 m), and were most frequent in the north-central region of the Gulf of Mexico. Killer whales are relatively uncommon in the northern Gulf of Mexico, with only 49 (CV=0.77) individuals estimated to occur there (CV=0.77) (Waring et al. 2010). Some previous estimates were much higher, but these suffered from low precision due to the relative rarity with which killer whales are sighted on Gulf of Mexico research cruises.

3.4.2.34.3 Population and Abundance

Killer whales are distributed worldwide but are not considered particularly abundant anywhere in the world. Research indicates there are well in excess of 50,000, and perhaps even more than 100,000 worldwide (Ford 2008). The number of killer whales in the waters of the east coast of the United States and eastern Canada is not known. However, killer whale abundance in these waters appears relatively low. Nonetheless, there are likely to be at least several hundred to several thousand in these waters (Waring et al. 2010).

Data are currently insufficient to calculate a population estimate for the western North Atlantic stock of killer whales. The best abundance estimate available for northern Gulf of Mexico killer whales is 28 (CV=1.02). This estimate is from a summer 2009 oceanic survey covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone. The minimum population estimate for the northern Gulf of Mexico is 14 killer whales (Waring et al. 2013).

3.4.2.34.4 Predator/Prey Interactions

Killer whales are apex predators and 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; 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 et al. 2005).

3.4.2.34.5 Species-Specific Threats

There are no significant species-specific threats to killer whales in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.35 Long-Finned Pilot Whale (*Globicephala melas*)

There are two species of pilot whales in the western Atlantic: the long-finned pilot whale, *Globicephala melas melas*, and the short-finned pilot whale, *G. macrorhynchus*. These species are difficult to differentiate at sea; therefore, the ability to separately assess the two stocks in U.S. Atlantic waters is limited.

3.4.2.35.1 Status and Management (Excerpts from Waring et al. (2013))

Long-finned pilot whales are not listed under the ESA but are protected under the MMPA. The structure of the Western North Atlantic stock of long-finned pilot whales is uncertain (Fullard et al. 2000; International Council of the Exploration of the Sea 1993). Morphometric (Bloch and Lastein 1993) and genetic (Fullard et al. 2000; Siemann 1994) studies have provided little support for stock structure across the Atlantic (Fullard et al. 2000). However, Fullard et al. (2000) have proposed a stock structure that is related to sea-surface temperature: (1) a cold-water population west of the Labrador/North Atlantic Current and (2) a warm-water population that extends across the Atlantic in the Gulf Stream.

3.4.2.35.2 Habitat and Geographic Range (Excerpts from Waring et al. (2010))

Long-finned pilot whales inhabit temperate and subpolar zones from North Carolina to North Africa (and the Mediterranean) and north to Iceland, Greenland and the Barents Sea (Abend 1993; Abend and Smith 1999; Buckland et al. 1993; Leatherwood et al. 1976; Sergeant 1962). They occur along the continental shelf break, in continental slope waters, and in areas of high topographic relief (Olson 2009).

They occur in high densities over the continental slope in the western North Atlantic during winter and spring and inhabit waters over the continental shelf in summer and fall. They are associated with the Gulf Stream wall and thermal fronts along the continental shelf edge (Waring et al. 2010). In coastal areas, long-finned pilot whale distribution in the western Atlantic is known to extend essentially from Canada to Cape Hatteras, North Carolina (Waring et al. 2010).

Northeast U.S. Continental Shelf Large Marine Ecosystem. In U.S. Atlantic waters, pilot whales (*Globicephala* spp.) are distributed principally along the continental shelf edge off the northeastern U.S. coast in winter and early spring (Abend and Smith 1999; Cetacean and Turtle Assessment Program 1982; Hamazaki 2002; Payne and Heinemann 1993). In late spring, pilot whales move onto Georges Bank and into the Gulf of Maine and more northern waters; they remain in these areas through late autumn (Cetacean and Turtle Assessment Program 1982; Payne and Heinemann 1993). Pilot whales tend to occupy areas of high relief or submerged banks. They are also associated with the Gulf Stream wall and thermal fronts along the continental shelf edge (Waring et al. 1992) and the two species overlap spatially along the mid-Atlantic shelf break between Cape Hatteras, North Carolina, and New Jersey (Payne and Heinemann 1993).

3.4.2.35.3 Population and Abundance (Excerpts from Waring et al. (2013))

There are estimated to be approximately 31,100 long-finned pilot whales in the western North Atlantic (this estimate likely includes a small number of short-finned pilot whales) (Best 2007; Olson 2009). Off the east coast of the United States, long- and short-finned pilot whales overlap, and no reliable method of distinguishing these two very similar species has been identified for sightings at sea (with the exception of genetic analysis from biopsy samples, which is not often done). The best available abundance estimates are from surveys conducted during the summer of 2004. These survey data are combined with an analysis of the spatial distribution of the two species based on genetic analyses of biopsy samples to derive separate abundance estimates (L. Garrison, National Marine Fisheries Service

Southeast Fisheries Science Center, personal communication). The resulting abundance estimate for long-finned pilot whales in U.S. waters is 12,619 (CV=0.37).

3.4.2.35.4 Predator/Prey Interactions

Both pilot whale species feed primarily on squid but also eat fish, including mackerel, cod, turbot, herring, hake, and dogfish (Bernard and Reilly 1999). They are also known to feed on shrimp (Gannon et al. 1997; Jefferson et al. 2008b). Feeding generally takes place at depths between 656 and 1,640 ft. (between 200 and 500 m) (Jefferson et al. 2008b). Some accounts of pilot whale attacks on small marine mammals are known, but pilot whales generally are not known to prey on marine mammals (Weller et al. 1996).

Killer whales are possible predators of long-finned pilot whales.

3.4.2.35.5 Species-Specific Threats

There are no significant species-specific threats to long-finned pilot whales in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

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

There are two species of pilot whales in the western Atlantic: the long-finned pilot whale, *Globicephala melas melas*, and the short-finned pilot whale, *G. macrorhynchus*. These species are difficult to differentiate at sea; therefore, the ability to separately assess the two stocks in U.S. Atlantic waters is limited. Only the short-finned pilot whale occurs in the Gulf of Mexico and Caribbean.

3.4.2.36.1 Status and Management

The short-finned pilot whale is not listed under the ESA but is protected under the MMPA. Studies are currently being conducted at the NMFS Southeast Fisheries Science Center to evaluate genetic population structure in short-finned pilot whales. The short-finned pilot whale population is managed as three stocks: Western North Atlantic stock, U.S. Virgin Islands stock, and Gulf of Mexico Oceanic stock. These three stocks are considered separate from the long-finned pilot whale population in the U.S. Atlantic Ocean.

3.4.2.36.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

Short-finned pilot whales range throughout warm temperate to tropical waters of the world, generally in deep offshore areas. Thus, the species occupies waters over the continental shelf break, in slope waters, and in areas of high topographic relief (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. Atlantic distribution in the open ocean is known to include the Gulf Stream and North Atlantic Gyre. Sightings of pilot whales (*Globicephala* spp.) in the western North Atlantic occur primarily near the continental shelf break ranging from Florida to the Nova Scotian Shelf (Mullin and Fulling 2003). Long-finned and short-finned pilot whales overlap spatially along the mid-Atlantic shelf break between Cape Hatteras, North Carolina, and New Jersey (Payne and Heinemann 1993). In addition, short-finned pilot whales are documented along the continental shelf and continental slope in the northern Gulf of Mexico (Hansen et al. 1996; Mullin and Fulling 2003; Mullin and Hoggard 2000), and in the Caribbean.

3.4.2.36.3 Population and Abundance (Excerpts from Waring et al. (2013))

The best available abundance estimates for the western North Atlantic stock of short-finned pilot whales are from surveys conducted during the summer of 2004 because these are the most recent surveys covering the full range of pilot whales in U.S. Atlantic waters. These survey data were combined with an analysis of the spatial distribution of the two species based on genetic analyses of biopsy samples to derive separate abundance estimates (L. Garrison, National Marine Fisheries Service Southeast Fisheries Science Center, personal communication). The resulting abundance estimate for short-finned pilot whales is 24,674 (CV=0.45). The best abundance estimate available for northern Gulf of Mexico short-finned pilot whales is 2,415 (CV=0.66). This estimate is from a summer 2009 oceanic survey covering waters from the 200-m isobath to the seaward extent of the U.S. Exclusive Economic Zone. The abundance of the Puerto Rico and U.S. Virgin Islands stock of short-finned pilot whales is unknown (Waring et al. 2013).

3.4.2.36.4 Predator/Prey Interactions

Pilot whales feed primarily on squid, to which they are generally well adapted (Jefferson et al. 2008b; Werth 2006), but they also take fish (Bernard and Reilly 1999). 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, and may even eat, dolphins during fishery operations (Olson 2009; Perryman and Foster 1980). They were also observed harassing sperm whales in the Gulf of Mexico (Weller et al. 1996).

This species is not known to have any predators (Weller 2008), but it may be subject to predation by killer whales.

3.4.2.36.5 Species-Specific Threats

There are no significant species-specific threats to short-finned pilot whales in the northwest Atlantic or Gulf of Mexico. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.37 Harbor Porpoise (*Phocoena phocoena*)

3.4.2.37.1 Status and Management

The harbor porpoise is not listed under the ESA but is protected under the MMPA. The Gulf of Maine–Bay of Fundy stock is the only stock of harbor porpoise under NMFS management within the Study Area.

3.4.2.37.2 Habitat and Geographic Range (Excerpts from Waring et al. (2013))

Harbor porpoises inhabit cool temperate-to-subpolar waters, often where prey aggregations are concentrated (Watts and Gaskin 1985). Thus, they are frequently found in shallow waters, most often near shore, but they sometimes move into deeper offshore waters. Harbor porpoises are rarely found in waters warmer than 63°F (17°C) (Read 1999) and closely follow the movements of their primary prey, Atlantic herring (Gaskin 1992).

Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems. During summer (July to September), harbor porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy region, generally in waters less than 150 ft. (460 m) deep (Gaskin 1977; Kraus et al. 1983; Palka 1995a; Palka 1995b), with a few sightings in the upper Bay of Fundy and on the northern edge of Georges Bank (Palka 2000). During fall (October to December) and spring (April to June), harbor porpoises are widely dispersed from New Jersey to Maine, with lower densities farther north and south.

They are seen from the coastline to deep waters (greater than 5,906 ft. or 1,800 m) (Westgate et al. 1998), although most of the population is found over the continental shelf. During winter (January to March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada. There does not appear to be a temporally coordinated migration or a specific migratory route to and from the Bay of Fundy region.

3.4.2.37.3 Population and Abundance

The best current abundance estimate of the Gulf of Maine/Bay of Fundy harbor porpoise stock is 79,883 (CV=0.32) based on a 2011 survey (Palka 2012). The minimum population estimate for the Gulf of Maine/Bay of Fundy harbor porpoise is 61,415 (Waring et al. 2013).

3.4.2.37.4 Predator/Prey Interactions

This species preys on a variety of fish and cephalopods. The harbor porpoise is known to be attacked and killed by common bottlenose dolphins (Jefferson et al. 2008b).

3.4.2.37.5 Species-Specific Threats

Harbor porpoises have been documented as bycatch in a variety of fisheries, including sink and drift gillnets, herring weirs, and pelagic long-lines (Waring et al. 2013; Zollett 2009).

3.4.2.38 Polar Bear (*Ursus maritimus*)

3.4.2.38.1 Status and Management

In May 2008**,** the polar bear was added as a threatened species under the ESA due to loss of sea ice habitat caused by climate change; it is also protected under the MMPA. Critical habitat was designated for areas of the Alaska coast, outside of the Study Area, in 2010. The polar bear is managed by the U.S. Fish and Wildlife Service under the Department of the Interior.

3.4.2.38.2 Habitat and Geographic Range

Polar bears prefer to inhabit areas of pack ice throughout the Arctic. Typically, they are found on the edge of the ice flow and in areas of moving ice. Much of their habitat depends on sea ice, and they generally do not spend large amounts of time on land, unless the ice has melted and they are in areas without ice access (Amstrup and DeMaster 1988). Monnett and Gleason (2006) present aerial survey results that indicate polar bears are observed on land at a much higher rate than in the water (3.8 percent of observations in water in years 1987–2003 and 19.9 percent in 2004) (Monnett and Gleason 2006). Observations of free-swimming polar bears from 1987 to 2003 showed that they can occur at a distance of 3 to 47 miles (4.8 to 75.6 km) from land and 14 to 217 miles (22.5 to 349.2 km) from pack ice (Monnett and Gleason 2006).

Newfoundland-Labrador Shelf Large Marine Ecosystem. The polar bear does not occur within the U.S. Exclusive Economic Zone, although it does occur at the northern extreme of the Study Area in association with pack ice between Canada and Greenland. Polar bears are found throughout the Canadian Arctic to Greenland and Svalbard, Norway. They were found as far south as James Bay, Newfoundland, and Iceland in the North Atlantic (Amstrup and DeMaster 1988; DeMaster and Stirling 1981). The Davis Strait polar bear subpopulation, which accounts for most of the polar bears that occur in the Study Area, is distributed in the Labrador Sea, eastern Hudson Strait, Davis Strait south of Cape Dyer, and southwest Greenland (Committee on the Status of Endangered Wildlife in Canada 2002).

3.4.2.38.3 Population and Abundance

There are three subpopulations of polar bear that occur within or very near the Study Area: Foxe Basin, Baffin Bay, and Davis Strait (Committee on the Status of Endangered Wildlife in Canada 2002; Hutchings and Festa-Bianchet 2009). Estimates of abundance for these subpopulations are 2,300 bears for the Foxe Basin subpopulation, 2,200 for the Baffin Bay subpopulation, and 1,400 for the Davis Strait subpopulation (Committee on the Status of Endangered Wildlife in Canada 2002). A recent comparison of population trends for polar bears in the Arctic showed that subpopulations were declining in Baffin Bay, Kane Basin, Western Hudson Bay, and Norwegian Bay (Hutchings and Festa-Bianchet 2009). Subpopulations in Foxe Basin and Davis Strait, which are both near or within the Study Area, are either stable or of uncertain status (Hutchings and Festa-Bianchet 2009).

3.4.2.38.4 Predator/Prey Interactions

Polar bears obtain most of their prey from the sea but rarely hunt directly in the water (Amstrup 2003; Jefferson et al. 2008b). They feed mainly on ringed seals and bearded seals. Although seals are their primary source of prey, they are known to hunt larger animals, such as walruses and even small beluga whales and narwhals (Rugh and Shelden 1993; Stirling 2009). Similar to other bear species, polar bears will feed on human refuse, and when trapped on land for long periods are known to feed on small amounts of terrestrial vegetation (Amstrup 2003). They sometimes feed on Arctic cod as well. Polar bears in Hudson Bay and southeastern Baffin Island are known to fast for many months, while ice is melting during the summer, returning to the ice when it re-forms in the autumn. It appears that these animals have amazing fasting abilities but generally do not fast if they have regular access to sea ice throughout the year. Polar bears hunt by waiting near a hole in the ice used by seals for breathing and then attack when the seal surfaces to breathe. They have a well-developed sense of smell, which they use to do much of their hunting (Amstrup 2003). In at least some areas, the diets of polar bears have shifted from species associated with ice (ringed and bearded seals) to species less associated with ice (harbor and harp seals) (McKinney et al. 2009).

Polar bears have no natural predators.

3.4.2.38.5 Species-Specific Threats

The primary threat to this species is climate change and associated sea ice loss. Changes in sea ice patterns thought to be caused by climate change is reducing the size, growth, reproduction, and survival of polar bears in affected areas and is significantly shrinking their available habitat (Amstrup 2003; Durner et al. 2009).

3.4.2.39 Ringed Seal (*Pusa hispida*)

3.4.2.39.1 Status and Management

The Arctic subspecies of ringed seals was listed as threatened under the ESA in 2012 and is protected under the MMPA. This species does not occur in the U.S. Exclusive Economic Zone in the Atlantic Ocean and therefore is not managed by NMFS. Although there is no genetic evidence or other data to differentiate stocks of ringed seals, the North Atlantic Marine Mammal Commission Scientific Committee has recognized three stock areas in the northwest Atlantic based primarily on the low likelihood of mixing between the areas. Area 1 is centered on Baffin Bay and includes northeastern Canada and West Greenland coincident with the northern extreme of the Study Area (North Atlantic Marine Mammal Commission 1997).

3.4.2.39.2 Habitat and Geographic Range

Ringed seal have a circumpolar distribution throughout the Arctic basin, Hudson Bay and straights, and the Bering, Okhotsk, and Baltic Seas. The distribution of ringed seals is strongly correlated with pack and land-fast ice (Born et al. 2002; Jefferson et al. 2008b) in areas over virtually any water depth (Reeves 1998a). In the western Atlantic, they occur as far south as northern Newfoundland, northward to the pole and throughout the Canadian Arctic. They also occur throughout the Greenland Large Marine Ecosystem and can be found south to as far as Labrador off the Canadian east coast in the Newfoundland-Labrador Shelf Large Marine Ecosystem (Hammill 2009).

3.4.2.39.3 Population and Abundance

Abundance of ringed seals is very difficult to estimate because of their inaccessible habitat and tendency to spend much of the breeding season hidden from view in dens or snow caves, when many pinniped estimates are made. Therefore, any estimates are of questionable accuracy and are probably underestimates. The North Atlantic Marine Mammal Commission Scientific Committee derived a rough estimate of the abundance of ringed seals in Area 1 (coincident with the northern extreme of the Study Area) of approximately 1.3 million seals, based on extending existing estimates to areas of similar habitat (North Atlantic Marine Mammal Commission 1997).

3.4.2.39.4 Predator/Prey Interactions

Ringed seals are opportunistic feeders and eat a wide variety of prey species. More than 70 prey species were identified, including fish and planktonic and benthic crustaceans (Hammill 2009). They mostly forage solitarily or in small groups typically in deep water, under ice floes, and in the benthic communities of shallower water. The amphipod *Themisto libellula* is known to be the dominant prey type in the diet of immature ringed seals from Grise Fiord, whereas Arctic cod (*Bweogadzls saida*) and polar cod (*Arctogadus glacialis*) compose the diet of adult ringed seals (Holst et al. 2001; Jefferson et al. 2008b).

Polar bears are the primary ringed seal predator, but some may also be taken by killer whales, Greenland sharks, and walruses (Hammill 2009).

3.4.2.39.5 Species-Specific Threats

Ringed seals are harvested for subsistence use by Arctic natives and are also caught incidentally in fishing gear. Climate change is potentially the most serious threat to ringed seal populations since much of their habitat depends on pack ice.

3.4.2.40 Bearded Seal (*Erignathus barbatus*)

3.4.2.40.1 Status and Management

The bearded seal is not listed under the ESA, although two Distinct Population Segments in the Pacific have been proposed as endangered. The bearded seal is protected under the MMPA. This species does not normally occur in the U.S. Atlantic Exclusive Economic Zone but does occur in waters of eastern Canada (Kovacs 2009). The population structure of this species is not well understood in the western North Atlantic.

3.4.2.40.2 Habitat and Geographic Range

Bearded seals have a circumpolar distribution in the Arctic, generally south of 80° N latitude, and are subarctic in some areas, such as the western North Atlantic. While they are typically strongly tied to ice, bearded seals are known to haul out on land, swim up rivers, and live in open-ocean areas for extended periods (Cleator 1996; Jefferson et al. 2008b).

Newfoundland-Labrador Shelf Large Marine Ecosystem and Scotian Shelf Large Marine Ecosystem. The preferred habitat is drifting pack ice in shallow waters. Bearded seals are found in the Arctic realm, within the following marine regions: North Greenland, West Greenland Shelf, Northern Labrador, Baffin Bay-Davis Strait, Hudson Complex, and the High Arctic Archipelago. This species spends most of its time near where the coastal ice forms and in less than 656 ft. (200 m) of water (Jefferson et al. 2008b; Kovacs 2009). Sightings outside the species' typical range were reported as far south as Cape Cod, Massachusetts.

3.4.2.40.3 Population and Abundance

Due to the patchy distribution of individuals moving with ice floes, it is difficult to make accurate abundance estimates for this species (Kovacs 2009), and no estimates exist specifically for the western Atlantic. The best available global population estimate for the bearded seal is 450,000 to 500,000, approximately half of which inhabit the Bering and Chukchi Seas (Jefferson et al. 2008b). Rough estimates based on aerial surveys conducted over a 35-year period indicated densities in Canadian waters to be approximately 0.24 seal per square kilometer in preferred habitat. The population estimate for bearded seals in Canadian waters during the survey period was 190,000 (Cleator 1996).

3.4.2.40.4 Predator/Prey Interactions

The bearded seal's diet is composed largely of demersal fish and benthic invertebrate species. Dominant prey items vary among seasons and regions. In the Bering and Chukchi Seas, bearded seals consume capelin, Arctic and saffron cod, long-snouted pricklebacks, sculpins, flatfishes, several species of snailfish, and eelpouts. Invertebrates preyed on are crabs, clams, snails, amphipods, shrimps, marine worms, and octopuses. The adult diet appears to differ somewhat from that of juveniles (Jefferson et al. 2008b; Kovacs 2009).

Polar bears, killer whales, and Greenland sharks are known bearded seal predators (Kovacs 2009).

3.4.2.40.5 Species-Specific Threats

Loss of sea ice is a potentially significant threat to the habitat of bearded seals.

3.4.2.41 Hooded Seal (*Cystophora cristata*)

3.4.2.41.1 Status and Management

Hooded seals are not listed under the ESA but are protected under the MMPA. The global hooded seal population was divided by the International Council for the Exploration of the Sea into three separate stocks based on specific breeding sites: Northwest Atlantic, Greenland Sea (”West Ice”), and White Sea (”East Ice”). The western North Atlantic stock (synonymous with the International Council for the Exploration of the Sea Northwest Atlantic Stock) give birth and nurse off the coast of eastern Canada in three specific areas: coastal Newfoundland and Labrador (an area that is known as the Front), the Gulf of St. Lawrence, and the Davis Strait (Waring et al. 2007).

3.4.2.41.2 Habitat and Geographic Range

Hooded seals are distributed in the Arctic and the cold temperate North Atlantic Ocean (Bellido et al. 2007). At sea, hooded seals stay primarily near continental coastlines but are known to wander widely.

This species follows the seasonal movement of pack ice, on which it breeds. In the Study Area, its primary range is around the Newfoundland-Labrador Shelf and Scotian Shelf (Bellido et al. 2007).

Newfoundland-Labrador Shelf and Scotian Shelf Large Marine Ecosystems. Hooded seals remain on the Newfoundland continental shelf during winter/spring (Stenson et al. 1996). Breeding and pupping areas are in the Gulf of St. Lawrence and north of Newfoundland and east of Labrador, as well as in the Davis Strait and near Jan Mayen Island in the Arctic Ocean (Hammill et al. 1997; Jefferson et al. 2008b; Kovacs 2008).

Northeast and Southeast U.S. Continental Shelf and Caribbean Sea Large Marine Ecosystems. Hooded seals are highly migratory and may wander as far south as Puerto Rico (Mignucci-Giannoni and Odell 2001), with increased occurrences from Maine to Florida. These appearances usually occur between January and May in New England waters, and in summer and autumn off the southeast U.S. coast and in the Caribbean (Harris et al. 2001; McAlpine et al. 1999; Mignucci-Giannoni and Odell 2001). Six hooded seal strandings were also reported between 1975 and 1996 in North Carolina, Florida, Georgia, Puerto Rico, and the U.S. Virgin Islands (Mignucci-Giannoni and Odell 2001).

3.4.2.41.3 Population and Abundance

The number of hooded seals in the western North Atlantic is relatively well known and is derived from pup production estimates produced from whelping (birthing) pack surveys. The best estimate of abundance for western North Atlantic hooded seals is 592,100 (SE=94,800). The minimum population estimate based on the 2005 pup survey results is 512,000. Present data are insufficient to calculate the minimum population estimate for U.S. waters (Waring et al. 2007).

3.4.2.41.4 Predator/Prey Interactions

The main prey species of hooded seals are redfish and cod, but they forage on squid and Greenland halibut as well (Hammill et al. 1997; Hauksson and Bogason 1997). Some overlap and competition exists for prey between hooded seals and harp seals (Tucker et al. 2009).

This species is preyed on by polar bears and killer whales (Kovacs 2009).

3.4.2.41.5 Species-Specific Threats

Although hooded seals are documented to be taken incidentally in commercial fishing gear, the level of take is very small compared to the size of the population. Hooded seals are also hunted commercially in Canada.

3.4.2.42 Harp Seal (*Pagophilus groenlandicus*)

3.4.2.42.1 Status and Management

The harp seal is not listed under the ESA but is protected under the MMPA. The harp seal is the most abundant pinniped in the western North Atlantic Ocean (Canada Department of Fisheries and Oceans 2003). The Western North Atlantic stock is the largest and is divided into two breeding herds: the Front herd, which breeds off the coast of Newfoundland and Labrador, and the Gulf herd, which breeds near the Magdalen Islands in the Gulf of St. Lawrence (Reeves et al. 2002b; Waring et al. 2004).

3.4.2.42.2 Habitat and Geographic Range

Harp seals are closely associated with drifting pack ice, where they breed and molt and forage in the surrounding waters (Lydersen and Kovacs 1993; Ronald and Healey 1981). Harp seals make extensive movements over much of the continental shelf within their winter range in the waters off Newfoundland (Bowen and Siniff 1999). The primary range of this species is throughout the Arctic, but the secondary range includes the western waters of the Scotian Shelf and the Northeast U.S. Continental Shelf.

Newfoundland-Labrador Shelf and Scotian Shelf Large Marine Ecosystems. Typically, harp seals are distributed in the pack ice of the North Atlantic segment of the Arctic Ocean and through Newfoundland and the Gulf of St. Lawrence (Reeves et al. 2002b). Most western North Atlantic harp seals congregate off the east coast of Newfoundland-Labrador (the Front) to pup and breed. The remainder (the Gulf herd) gathers to pup near the Magdalen Islands in the Gulf of St. Lawrence (Morissette et al. 2006; Ronald and Dougan 1982).

Northeast U.S. Continental Shelf Large Marine Ecosystem. The number of sightings and strandings of harp seals off the northeastern United States has been increasing (Harris et al. 2002; McAlpine and Walker 1999; Stevick and Fernald 1998). These occurrences are usually during January through May (Harris et al. 2002), when the Western North Atlantic stock of harp seals is at its most southern point in distribution (Waring et al. 2004). Harp seals occasionally enter the Bay of Fundy, but McAlpine and Walker (1999) suggested that winter ocean surface currents might limit the probability of occurrences in this bay.

3.4.2.42.3 Population and Abundance

The best estimate of abundance for western North Atlantic harp seals is 6.9 million (95 percent CI 6.0–7.7 million). The minimum population estimate based on the 2008 pup survey results is 6.5 million (CV=0.06) seals. Data are insufficient to calculate the minimum population estimate for U.S. waters (Waring et al. 2013).

3.4.2.42.4 Predator/Prey Interactions

Harp seals feed on a variety of prey, which vary with age class, season, location, and year (Lavigne 2008). Prey preference studies have revealed that harp seals prefer small fish to crustaceans (Lindstrom et al. 1998). The main prey species of harp seals are sand eels, herring, and cod. Capelin also is an important food source of the harp seal (Hauksson and Bogason 1997). Contrary to popular belief, harp seals rarely eat commercially important Atlantic cod (*Gadus morhua*) (Lavigne 2008). Most foraging occurs at depths of less than 90 m, although dives as deep as 568 m have been recorded (Folkow et al. 2004; Lydersen and Kovacs 1993). Harp seals feed intensively during the winter and summer and less so during the spring and fall migrations or during pupping and molting (Ronald and Healey 1981). Some overlap and competition exists for prey between hooded seals and harp seals (Tucker et al. 2009).

This species is preyed on by polar bears, killer whales, and sharks (Lavigne 2008).

3.4.2.42.5 Species-Specific Threats

Although harp seals are documented to be taken incidentally in commercial fishing gear, the level of take is very small compared to the size of the population. Harp seals are also hunted commercially in Canada and Greenland.

3.4.2.43 Gray Seal (*Halichoerus grypus*)

3.4.2.43.1 Status and Management

The gray seal is not listed under the ESA but is protected under the MMPA. The gray seal is found on both sides of the North Atlantic, with three major populations: eastern Canada, northwestern Europe, and the Baltic Sea (Katona et al. 1993; Waring et al. 2010). These stocks are separated by geography, differences in the breeding season, and genetic variation (Waring et al. 2010). There are two breeding concentrations in eastern Canada: one at Sable Island and the other on the pack ice in the Gulf of St. Lawrence; they are treated as separate populations for management purposes (Mohn and Bowen 1996).

3.4.2.43.2 Habitat and Geographic Range

The Western North Atlantic stock is equivalent to the eastern Canada population and ranges from New York to Labrador (Waring et al. 2013). The gray seal is considered a coastal species and may forage far from shore but does not appear to leave the continental shelf regions (Lesage and Hammill 2001). Gray seals haul out on ice, exposed reefs, or beaches of undisturbed islands (Lesage and Hammill 2001). Haul-out sites are often near rough seas and riptides (Hall and Thompson 2008; Jefferson et al. 2008b; Katona et al. 1993). Remote uninhabited islands tend to have the largest gray seal haul-outs (Reeves et al. 1992). In the Study Area, the primary range of this species includes the northwestern waters of the Newfoundland-Labrador Shelf, the Scotian Shelf, and the Northeast U.S. Continental Shelf (Davies 1957; Hall and Thompson 2008). In the western North Atlantic Ocean, the gray seal population is centered in the Canadian maritimes, including the Gulf of St. Lawrence and the Atlantic coasts of Nova Scotia, Newfoundland, and Labrador.

Newfoundland-Labrador and Scotian Shelf Large Marine Ecosystems. The largest concentrations of gray seals are found in the southern half of the Gulf of St. Lawrence, where most seals breed on ice, and around Sable Island, where most seals breed on land (Davies 1957; Hammill and Gosselin 1995; Hammill et al. 1998).

Northeast U.S. Continental Shelf Large Marine Ecosystem. Gray seals range south into the northeastern United States, with strandings as far south as North Carolina (Hammill et al. 1998; Waring et al. 2004). Small numbers of gray seals and pupping have been observed on several isolated islands along the central coast of Maine and in Nantucket Sound (the southernmost breeding site is Muskeget Island) (Andrews and Mott 1967; Rough 1995; Waring et al. 2004). Resident colonies and pupping have been observed since 1994 on Seal and Green Islands in Penobscot Bay off the central coast of Maine (Waring et al. 2004). Spring and summer sightings off Maine are primarily on offshore ledges of the central coast of Maine (Richardson et al. 1995). In the late 1990s, a year-round breeding population of approximately 400 animals was documented on outer Cape Cod and Muskeget Island (Barlas 1999; Waring et al. 2004).

3.4.2.43.3 Population and Abundance

A 2004 survey of the Canadian population obtained estimates ranging between 208,720 (SE=29,730) and 223,220 (SE=17,376). The herd on Sable Island is growing, but the Gulf of St. Lawrence population has changed little (Canada Department of Fisheries and Oceans 2003). This decline is attributed to a sharp decline in the quantity of suitable ice breeding habitat in the southern Gulf of St. Lawrence, possibly the result of global climate change (Hammill et al. 2003). A minimum of 1,000 pups were born in the northeastern United States during 2002 (Wood et al. 2003), but present data are insufficient to calculate the minimum population estimate for U.S. waters (Waring et al. 2010).

3.4.2.43.4 Predator/Prey Interactions

This species preys on a variety of deep-ocean and bottom-dwelling organisms. They also prey on schooling fish and occasionally sea birds. Examples of prey are smelt, skates, and molluscs (Jefferson et al. 2008b). Feeding during the breeding season is minimal (Hauksson and Bogason 1997).

This species is preyed on by sharks (Jefferson et al. 2008b). They are also probably prey of killer whales (Weller 2008).

3.4.2.43.5 Species-Specific Threats

A review of 405 cases of marine mammal mortalities on Cape Cod and southeastern Massachusetts from 2000 to 2006 concluded that gray seals are highly susceptible to human interaction. Forty-five percent of gray seal deaths are due to interactions with humans (Bogomolni et al. 2010). In U.S. waters, approximately 500 gray seals are killed annually as bycatch, most of which are by sink gillnets in northeast Atlantic fisheries (Waring et al. 2010). In Canada, a few hundred gray seals are killed each year by hunters (Waring et al. 2010).

3.4.2.44 Harbor Seal (*Phoca vitulina*)

3.4.2.44.1 Status and Management

The harbor seal is not listed under the ESA but is protected under the MMPA. This is the most common and frequently reported seal in the northeastern United States (Agler et al. 1993). Currently, harbor seals along the coast of the eastern United States and Canada represent a single population (Temte et al. 1991; Waring et al. 2010).

3.4.2.44.2 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 a coastal species, rarely found more than 7.7 mi. (20 km) from shore, and frequently occupy bays, estuaries, and inlets (Baird 2001). Individual seals were observed several kilometers upstream in coastal rivers (Baird 2001). Haul-out sites vary but include intertidal and subtidal rock outcrops, sandbars, sandy beaches, and even peat banks in salt marshes (Burns 2008; Gilbert and Guldager 1998; Prescott 1982; Schneider and Payne 1983; Wilson 1978). Harbor seals occur in the cold and temperate nearshore waters of the northwest Atlantic, typically above 30° N. In the Study Area, their distribution includes the Gulf of St. Lawrence, the Scotian Shelf, the Gulf of Maine, the Bay of Fundy, and the Northeast U.S. Continental Shelf.

Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf Large Marine Ecosystems. In U.S. waters, breeding and pupping normally occur in waters north of the New Hampshire and Maine borders, although breeding is recorded as far south as Cape Cod (Katona et al. 1993; Waring et al. 2010). Harbor seals are found year-round in the coastal waters of eastern Canada and Maine and occur from the southern New England coast to the New Jersey coast from September to May (Katona et al. 1993; Waring et al. 2010). A general southward movement from the Bay of Fundy to southern New England waters occurs in autumn and early winter (Barlas 1999; Jacobs and Terhune 2000; Rosenfeld et al. 1988; Whitman and Payne 1990). A northward movement from southern New England to Maine and eastern Canada occurs before the pupping season, which takes place from mid-May through June along the Maine coast (deHart 2002; Kenney 1994; Richardson et al. 1995; Whitman and Payne 1990; Wilson 1978).

Southeast U.S. Continental Shelf Large Marine Ecosystem. Rare sightings and strandings were recorded through the Carolinas and as far south as Florida (Waring et al. 2013).

3.4.2.44.3 Population and Abundance

The NMFS 2010 Stock Assessment Report states that there is insufficient data to calculate a minimum population estimate for Western North Atlantic harbor seal stock; however, the NMFS 2009 Stock Assessment Report indicated the best estimate of abundance for this stock was 99,340 (CV=0.097) (Waring et al. 2009). An estimated 5,575 harbor seals overwintered in southern New England in 1999, increasing from an estimated 2,834 in 1981 (Barlas 1999).

3.4.2.44.4 Predator/Prey Interactions

The main prey species of the harbor seal are cod, some rockfish species, sand eels, saithe, herring, catfish, 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. There is no seasonal variation in prey species, but capelin and herring are more numerous in the fall and winter (Hauksson and Bogason 1997; Jefferson et al. 2008b; Reeves et al. 1992).

Adult harbor seals are known to be preyed on by killer whales, sharks, and Steller sea lions, and pups may be preyed on by eagles, ravens, gulls, and coyotes (Burns 2008; Weller 2008).

3.4.2.44.5 Species-Specific Threats

There are no significant species-specific threats for harbor seals in the western North Atlantic. Section 3.4.2.4 (General Threats to Marine Mammals) discusses threats to marine mammals.

3.4.2.45 Walrus (*Odobenus rosmarus*)

3.4.2.45.1 Status and Management

The walrus is not listed under the ESA but is protected under the MMPA. The walrus is managed by the U.S. Fish and Wildlife Service under the Department of the Interior. Five subpopulations of the Atlantic subspecies are suggested, based on genetic analysis. These subpopulations inhabit the Hudson Strait, West Greenland, Northwest Greenland, East Greenland, and Franz Josef Land-Svalbard (Andersen et al. 2009). The Hudson Strait subpopulation occurs within the northern extreme of the Study Area but does not normally occur in U.S. east coast waters.

3.4.2.45.2 Habitat and Geographic Range

Walruses occur in shallow, continental shelf areas and are seldom found in deep waters. Walruses haul out on ice floes and sandy beaches or rocky shores, along remote stretches of mainland coastlines or islands (Jefferson et al. 2008b; Kastelein 2009).

West Greenland and Newfoundland-Labrador Shelf Large Marine Ecosystems. Walruses are found throughout the Atlantic realm, around the tip of Greenland, and throughout the North Atlantic waters of Canada. This includes north Greenland, north and east Iceland, the east Greenland Shelf, the west Greenland Shelf, northern Grand Banks-southern Labrador, northern Labrador, Baffin Bay-Davis Strait, the Hudson Complex, High Arctic Archipelago, and the Beaufort-Amundsen-Viscount and Melville-Queen Maud Islands (Jefferson et al. 2008b). Walruses are known to stay fairly close to land for most of their lives and make shallow dives inshore from the continental shelf and slope, so they do not regularly occur in deep oceanic waters. Migration of the subpopulation in the Hudson Strait to west Greenland suggests that there is a perennial migration in the Baffin Bay region for the Atlantic subspecies (Andersen et al. 2009). When the ice breaks up along the western coast of Greenland, with the warm water brought in by the Irminger Current from the south, it is thought that there is room for a northward migration by these walruses.

3.4.2.45.3 Population and Abundance

There are thought to be roughly 10,000 walruses in the western Atlantic population (the Atlantic subspecies) (Kastelein 2009); however, there are no accurate numbers for the portion of the population that occurs within the Study Area. The North Atlantic Marine Mammal Commission (undated) identifies eight putative stocks in the Atlantic ranging from 500 to 6,000 individuals.

3.4.2.45.4 Predator/Prey Interactions

Walruses are primarily benthic feeders, with a large proportion of their prey consisting of molluscs (Andersen et al. 2009; Kastelein and Wiepkema 1989; Stewart et al. 2003). They use their tusks to plow through the bottom sediments and dig up prey, most of which they find in the upper few centimeters of sediment or on or just above the bottom. Walrus diet also consists of snails, soft-shell crabs, amphipods, shrimp, sea cucumbers, tunicates, and slow-moving fish. Some prey on seals, small whales, and seabirds and may occasionally scavenge marine mammal carcasses. Walruses are known to consume between 88 and 176 pounds (lb.) (40 and 80 kg) of food per day (Jefferson et al. 2008b; Kastelein and Wiepkema 1989).

Walruses are preyed on by killer whales and polar bears (Jefferson et al. 2008b).

3.4.2.45.5 Species-Specific Threats

Illegal hunting and human activities near haul-outs pose a potentially significant threat to walrus.

3.4.2.46 West Indian Manatee (*Trichechus manatus*)

3.4.2.46.1 Status and Management

West Indian manatees are listed as endangered under the ESA and as depleted under the MMPA. The West Indian manatee is divided into the Florida (*Trichechus manatus latirostris*) and Antillean (*Trichechus manatus manatus*) subspecies (Lefebvre et al. 2001). Both subspecies may be found within the Study Area although the Antillean manatee only occurs in the Caribbean Sea Large Marine Ecosystem, extending eastward to Puerto Rico. The Florida population is closely monitored and managed by the U.S. Fish and Wildlife Service and the Florida Fish and Wildlife Conservation Commission. The Florida manatee population is divided into four management units: the Upper St. Johns River (4 percent of the population), Atlantic Coast (46 percent), Southwest Florida (38 percent), and Northwest Florida (12 percent). Data indicate that the Upper St. Johns River and Northwest Florida management units are flourishing, and the Atlantic Coast management unit is likely stable. The U.S. Fish and Wildlife Service is researching the status of the Southwest Florida management unit (U.S. Fish and Wildlife Service 2010). Preliminary analyses from U.S. Fish and Wildlife Service indicate that all four management units are doing well. Critical habitat is designated at multiple inland rivers and coastal waterways throughout Florida, although the designation does not define any primary constituent elements. The designated critical habitat only overlaps with the Study Area within the St. Johns (Mayport), Banana Rivers (Port Canaveral), St. Mary's River entrance channel (Kings Bay), and a small portion of inland waters encompassed by the South Florida Ocean Measurement Facility Testing Range boundary (Figure 3.4-2). However, the Mayport basin and the Trident basin are not considered critical habitat by U.S. Fish and Wildlife Service. A petition to revise manatee critical habitat was submitted

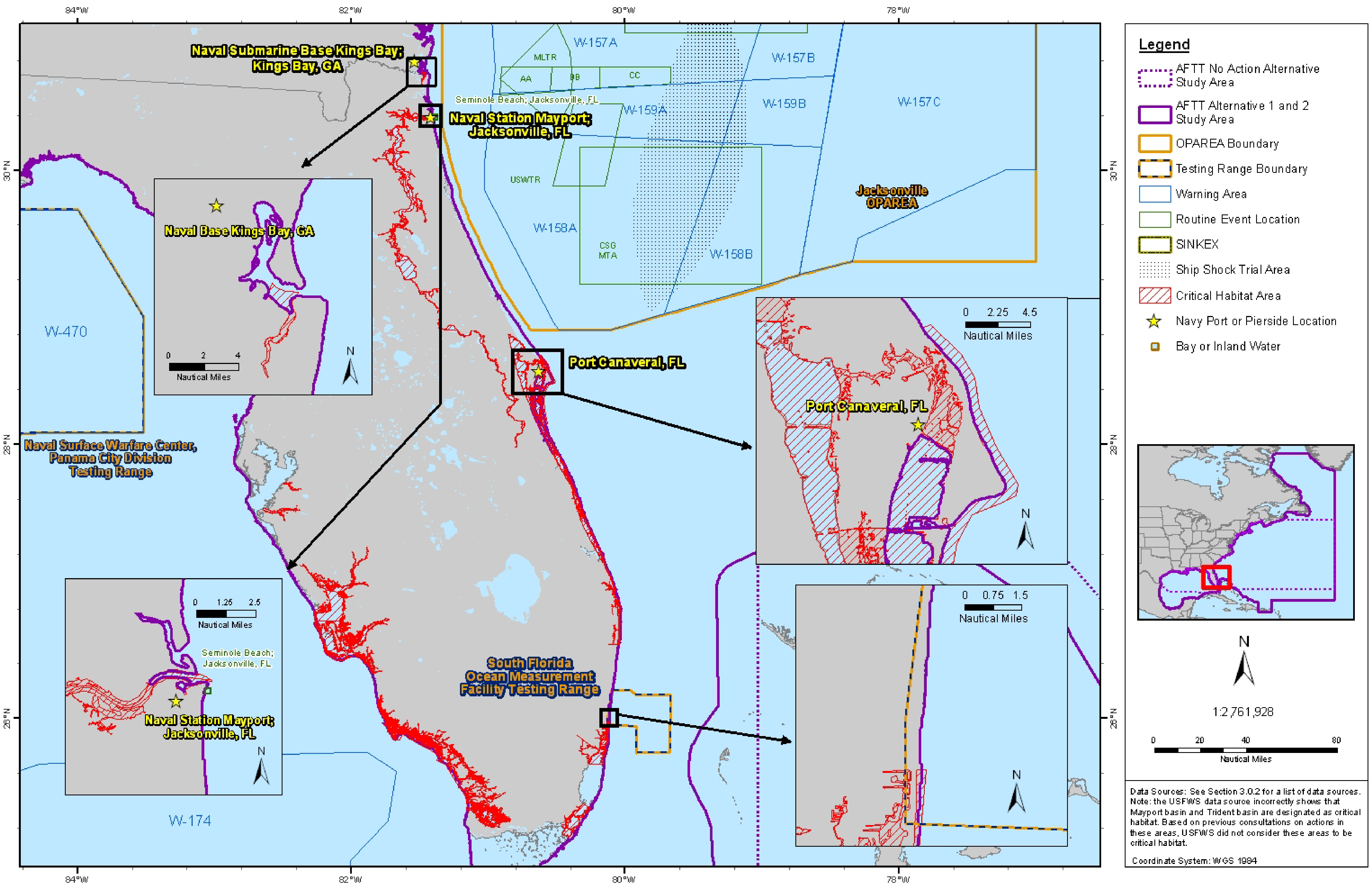

Figure 3.4-2: Designated Critical Habitat Areas for Florida Manatee in the Study Area

AFTT: Atlantic Fleet Training and Testing; CSG MTA: Carrier Strike Group Mine Training Area; FL: Florida; GA: Georgia; MLTR: Missile Laser Training Range; OPAREA: Operating Area; SINKEX: Sinking Exercise; USWTR: Undersea Warfare Training Area

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in 2009, and a 12-month finding on that petition by U.S. Fish and Wildlife Service stated that revisions should be made, including defining primary constituent elements, but sufficient funding is not currently available (FR 75 (7): 1574-1581, January 12, 2010).

3.4.2.46.2 Habitat and Geographic Range (Excerpts from U.S. Fish and Wildlife Service 2010 in Waring et al. (2010))

Manatees are found in coastal marine, brackish, and freshwater habitats. They are typically found in sea grass beds, canals, creeks, embayments, and lagoons near the mouths of rivers and sloughs (Lefebvre et al. 2000). Habitat selection is influenced by food, water temperatures, and freshwater resources. Females with calves are influenced by additional factors when selecting habitats, including ambient noise, currents, and increased amounts of forage (Gannon et al. 2007). Groups of manatees, sometimes in the hundreds, often congregate near sources of warm water (Deutsch et al. 2003; Jefferson et al. 2008b).

Florida manatees are found throughout the southeastern United States. Because manatees are a sub-tropical species with little tolerance for cold, they are generally restricted to the inland and coastal waters of peninsular Florida during the winter, when they shelter in or near warm-water springs, industrial effluents, and other warm water sites (Hartman 1979; Lefebvre et al. 2001; Stith et al. 2006). In warmer months, manatees leave these sites and can disperse great distances. Individuals have been sighted as far north as Massachusetts, as far west as Texas, and in all states in between (Fertl et al. 2005; Rathbun 1988; Schwartz 1995; U.S. Fish and Wildlife Service Jacksonville Field Office 2008). Warm-weather sightings are most common in Florida and coastal Georgia.

Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems. In the Study Area, the West Indian manatee (Florida subspecies) occurs from the southeastern United States to the Caribbean (Jefferson et al. 2008b; Morales-Vela et al. 2003). The West Indian manatee's primary range extends along both the Atlantic and Gulf coasts of Florida, while the secondary range extends north to the coastal waters of North Carolina on the east side, and into the Gulf of Mexico on the west side. They are reported regularly in coastal rivers of Georgia and South Carolina in warmer months (Lefebvre et al. 2001). Manatees are common in the St. Johns River and Port Canaveral and may have limited seasonal occurrence in the Pascagoula River, Great Bay, Sabine Lake, and Galveston Bay.

Caribbean Large Marine Ecosystems. The Antillean subspecies of West Indian manatee is only found in eastern Mexico and Central America, northern and eastern South America, and in the Greater Antilles (Lefebvre et al. 1989) within the Caribbean Large Marine Ecosystem. All studies suggest that manatees in Puerto Rico are most often detected in protected areas around cays, in secluded bays, and shallow seagrass beds east of San Juan, the east, south, and southwest coasts, and not far from fresh water sources (U.S. Fish & Wildlife Service Caribbean Field Office 2009).

3.4.2.46.3 Population and Abundance

The exact population for the West Indian manatee is unknown; however, the highest minimum count of 5,067 Florida manatees was recorded based on a January 2010 synoptic survey (U.S. Fish and Wildlife Service 2010).

3.4.2.46.4 Predator/Prey Interactions

West Indian manatees are herbivorous and are known to consume more than 60 species of plants. They typically feed on bottom vegetation, plants in the water column, and shoreline vegetation, such as hyacinths and marine sea grasses (Reynolds et al. 2009). In some areas, they are known to feed on algae and parts of mangrove trees (Jefferson et al. 2008b; Mignucci-Giannoni and Beck 1998).

Although large sharks, crocodiles, and killer whales are all considered to be potential predators, there is little evidence to confirm this (Weller 2008).

3.4.2.46.5 Species-Specific Threats

The Florida manatee is negatively impacted by cold stress, hurricanes, toxic red tide poisoning, habitat destruction (such as loss of seagrass), and other natural and human-made factors. However, vessel strikes are the single greatest cause of death for Florida manatees, accounting for 24 percent of manatee deaths in Florida during the last 30 years (Jett and Thapa 2010). A review of research on the effectiveness of laws reducing boat speeds in areas of known manatee habitat indicated that reducing boat speeds in specific areas is an appropriate, reasonable, and defensible management action although more studies on the effectiveness of boat speed reduction are suggested (Calleson and Frohlich 2007).

3.4.3 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 2.8-1 through 2.8-3 present the proposed training and testing activities for each alternative, the typical locations where those activities occur, the number of events, and the ordnance typically expended for each activity. The potential stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to marine mammals in the Study Area that are analyzed below include the following:

- Acoustic (sonar and other active acoustic sources; explosives; pile driving; swimmer defense airguns; weapons firing, launch, and impact noise; vessel noise; aircraft noise)
- Energy (electromagnetic devices and high energy lasers)
- Physical disturbance and strike (vessels, in-water devices, military expended materials, seafloor devices)
- Entanglement (fiber optic cables, guidance wires, and parachutes)
- Ingestion (munitions and military expended materials other than munitions)
- Secondary stressors

In this analysis, marine mammal species are grouped together based on similar biology (such as hearing) or behaviors (such as 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 the walrus), the polar bear, and the West Indian manatee.

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. Where impacts can be quantified, the analysis will be species-specific. In addition, if activities are expected to occur only in or will be concentrated in certain areas, the discussion will be geographically specific if applicable. Mitigation measures have been designed to minimize the potential impacts wherever possible and practicable. The approach to mitigation and the details of each measure proposed are discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring.)

3.4.3.1 Acoustic Stressors

3.4.3.1.1 Non-Impulsive and Impulsive Sound Sources

Long recognized by the scientific community (Payne and Webb 1971), and summarized by the National Academies of Science, human-generated sound could possibly harm marine mammals or significantly interfere with their normal activities (National Research Council 2005). 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 sound, 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 animal's physical condition, prior experience with the sound, and proximity to the source of the sound.

Methods used to predict acoustic effects on marine mammals build on the Conceptual Framework for Assessing Effects from Sound Producing Activities (Section 3.0.5.7.1). Additional research specific to marine mammals is presented where available.

3.4.3.1.2 Analysis Background and Framework

3.4.3.1.2.1 Direct Injury

The potential for direct injury to marine mammals is inferred from terrestrial mammal experiments and from post-mortem examination of marine mammals believed to have been exposed to underwater explosions (Ketten et al. 1993; Richmond et al. 1973; Yelverton et al. 1973). Additionally, noninjurious effects on marine mammals are extrapolated to injurious effects based on data from terrestrial mammals to estimate the potential for injury (Southall et al. 2007). Actual effects on marine mammals may differ due to anatomical and physiological adaptations to the marine environment; e.g., some characteristics such as a reinforced trachea and flexible thoracic cavity (Ridgway and Dailey 1972) may or may not decrease the risk of lung injury.

Potential direct injury from non-impulsive sound sources, such as sonar, is unlikely due to lower peak pressures and slower rise times than potentially injurious sources such as explosives. Non-impulsive sources also lack the strong shock wave associated with an explosion. Therefore, primary blast injury and barotrauma (i.e., injuries caused by large, rapid pressure changes) would not occur due to exposure to non-impulsive sources such as sonar. The theories of sonar-induced acoustic resonance and bubble formation are discussed below. Although these phenomena are feasible under extreme, controlled laboratory conditions, they are difficult to replicate in the natural environment and are therefore unlikely to occur.

<u>Primary Blast Injury and Barotrauma</u>

The greatest potential for direct, nonauditory tissue effects is primary blast injury and barotrauma after exposure to high amplitude impulsive sources, such as explosions. Primary blast injury refers to those injuries that result from the initial compression of a body exposed to a blast wave. Primary blast injury is usually limited to gas-containing structures (e.g., lung and gut) and the auditory system (Craig and Hearn 1998; Craig Jr. 2001; Phillips and Richmond 1990). Barotrauma refers to injuries caused when large pressure changes occur across tissue interfaces, normally at the boundaries of air-filled tissues such as the lungs. Primary blast injury to the respiratory system, as measured in terrestrial mammals, may consist of lung contusions (lung bruises), pneumothorax (collapsed lung), pneumomediastinum (air in the chest between the lungs), traumatic lung cysts, or interstitial or subcutaneous emphysema (collection of air outside of the lungs) (Phillips and Richmond 1990). These injuries may be fatal, depending on the severity of the trauma. Rupture of the lung may introduce air into the vascular system, possibly producing air emboli that can cause a stroke or heart attack by restricting oxygen delivery to these organs. Though often secondary in life-threatening severity to pulmonary blast trauma, the gastrointestinal tract can also suffer contusions (bruises) and lacerations (cuts) from blast exposure, particularly in air-containing regions of the tract. Potential traumas include hematoma (collection of blood outside of a blood vessel), bowel perforation, mesenteric tears, and ruptures of the hollow abdominal viscera (organs). Although hemorrhage of solid organs (e.g., liver, spleen, and kidney) from blast exposure is possible, rupture of these organs is rarely encountered.

The only known occurrence of mortality or injury to a marine mammal due to a U.S. Navy training or testing event involving impulsive sources occurred in March 2011. A group of long-beaked common dolphins entered the 640 m mitigation zone surrounding an explosive with a net explosive weight of 3.97 kg (8.8 lb.) set at a depth of 48 feet, approximately 0.5–0.75 nm from shore. One minute after detonation, three animals were observed at the surface, and a fourth animal stranded 42.3 miles (68 km) to the north of the detonation site three days later. Upon necropsy, all four animals were found to have sustained typical mammalian primary blast injuries (Danil and St. Ledger 2011). Section 3.4.3.1.2.7 (Stranding) provides more information on this topic.

Auditory Trauma

Relatively little is known about auditory system trauma in marine mammals resulting from a known sound exposure. A single study spatially and temporally correlated the occurrence of auditory system trauma in humpback whales with the detonation of a 5,000 kg (11,023 lb.) explosive (Ketten et al. 1993). The exact magnitude of the exposure in this study cannot be determined, but it is likely the trauma was caused by the shock wave produced by the explosion. There are no known occurrences of direct auditory trauma in marine mammals exposed to tactical sonar or other non-impulsive sound sources (Ketten 2012). The potential for auditory trauma in marine mammals exposed to impulsive sources (e.g., explosions) is inferred from tests of submerged terrestrial mammals exposed to underwater explosions (Ketten et al. 1993; Richmond et al. 1973; Yelverton et al. 1973).

Acoustic Resonance

Acoustic resonance occurs when an object is vibrated at its resonant frequency, resulting in enhanced vibration of that object. In 2002, NMFS convened a panel of government and private scientists to consider the hypothesis of mid-frequency sonar-induced resonance of gas-containing structures (i.e., lungs) (National Oceanic and Atmospheric Administration 2002). It 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 that group were that resonance in air-filled structures was not likely to have caused a mass stranding event in the Bahamas in 2000 (National Oceanic and Atmospheric Administration 2002). The frequencies at which resonance was predicted to occur in uncollapsed lungs were below 50 Hz, well below the frequencies used by the mid-frequency sonar systems associated with the Bahamas event (National Oceanic and Atmospheric Administration 2002). Furthermore, air cavity vibrations were not considered to be of sufficient magnitude to cause tissue damage, even at the worst-case resonant frequencies that would lead to the greatest vibratory response. These same conclusions would apply to other training and testing activities involving acoustic sources. Therefore, the Navy concludes that acoustic resonance leading to tissue damage is not likely under realistic conditions during training and testing, and this type of impact is not considered further in this analysis.

Bubble Formation (Acoustically Induced)

A suggested indirect cause of injury to marine mammals is rectified diffusion (Crum and Mao 1996), the process of increasing the size of a bubble by exposing it to a sound field. The process depends on many factors, including the sound pressure level 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 tissue hemorrhage (injury) occurs; (2) bubbles develop to the extent that an immune response is triggered or nervous system 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. The probability of rectified diffusion, or any other indirect tissue effect, will necessarily be based on what is known about the specific process involved. Rectified diffusion is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate nitrogen gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard 1979). The dive patterns of some marine mammals (for example, beaked whales) are theoretically predicted to induce greater nitrogen gas supersaturation (Houser et al. 2001). If surface intervals between dives are short, there is insufficient time to clear nitrogen in tissues accumulated due to pressures experienced while diving. Subsequent dives can increase tissue nitrogen accumulation, leading to greater levels of nitrogen saturation at each ascent. If rectified diffusion were possible in marine mammals exposed to a high level of 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 (e.g., nausea, disorientation, localized pain, breathing problems, etc.).

It is unlikely that the short duration of sonar or explosion sounds would last long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis is also suggested: stable microbubbles could be destabilized by high-level sound exposures so bubble growth would occur through static diffusion of gas out of the 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. Recent research with *ex vivo* supersaturated bovine tissues suggests that for a 37 kHz signal, a sound exposure of approximately 215 dB re 1 µPa would be required before microbubbles became destabilized and grew (Crum et al. 2005). Assuming spherical spreading loss and a nominal sonar source level of 235 dB re 1 µPa at 1 m, a whale would need to be within 33 ft. (10 m) of the sonar dome to be exposed to such sound levels. Furthermore, tissues in the study were supersaturated by exposing them to pressures of 400 to 700 kilopascals (kPa) for periods of hours and then releasing them to ambient pressures. Assuming the equilibration of gases with the tissues occurred when the tissues were exposed to the high pressures, levels of supersaturation in the tissues could have been as high as 400 to 700 percent. These levels of tissue supersaturation are substantially higher than model predictions for marine mammals (Houser et al. 2001). It is improbable that this mechanism would be responsible for stranding events or traumas associated with beaked whale strandings. Both the degree of supersaturation and exposure levels observed to cause microbubble destabilization are unlikely to occur, either alone or in concert.

There is considerable disagreement among scientists as to the likelihood of bubble formation in diving marine mammals (Evans and Miller 2003; Piantadosi and Thalmann 2004). Although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Fernández 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. Prior experimental work demonstrates that the postmortem presence of bubbles following decompression in laboratory animals can occur as a result of invasive investigative procedures (Stock et al. 1980).

Nitrogen Decompression

Although not a direct injury, variations in diving behavior or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation (Hooker et al. 2012; Jepson et al. 2003; Saunders et al. 2008). The mechanism for bubble formation would be different from rectified diffusion, but the effects would be similar. Although hypothetical, the potential process is under debate in the scientific community (Hooker et al. 2012; Saunders et al. 2008). The hypothesis speculates 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 (Fernández et al. 2005; Hooker et al. 2012; Jepson et al. 2003). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation.

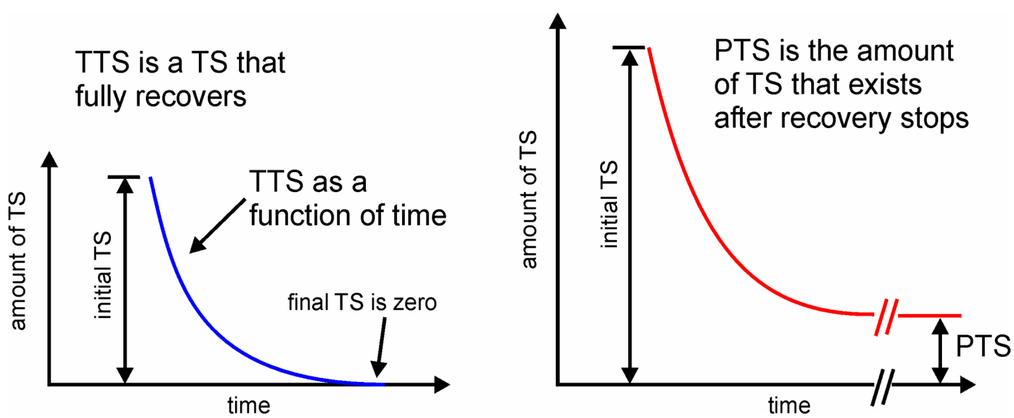
Recent modeling suggests that even unrealistically rapid rates of ascent from normal dive behaviors are unlikely to result in supersaturation to the extent that bubble formation would be expected in beaked whales (Zimmer and Tyack 2007). Tyack et al. (2006) suggested that emboli observed in animals exposed to mid-frequency active sonar (Fernández et al. 2005; Jepson et al. 2003) could stem instead from a behavioral response that involves repeated dives, shallower than the depth of lung collapse.
A bottlenose dolphin was trained to repetitively dive to specific depths 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).

More recently, 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 (e.g. fat, bone lipid) to the point that they are supersaturated when the animals are at the surface (Hooker et al. 2009). 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 has been demonstrated in bycatch animals drowned at depth and brought to the surface (Moore et al. 2009). Since bubble formation is facilitated by compromised blood flow, it has been suggested that rapid stranding may lead to bubble formation in animals with supersaturated, long-halftime tissues because of the stress of stranding and the cardiovascular collapse that can accompany it (Houser et al. 2009).

A fat embolic syndrome 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. Recently, Dennison et al. (2011) reported on investigations of dolphins stranded in 2009–2010 and, using ultrasound, identified gas bubbles in kidneys of 21 of 22 live-stranded dolphins and in the liver of 2 two of 22. The authors postulated that stranded animals are unable to recompress by diving, and thus may retain bubbles that are otherwise re-absorbed in animals that can continue to dive. The researchers concluded that the minor bubble formation observed can be tolerated since the majority of stranded dolphins released did not re-strand (Dennison et al. 2011). Recent modeling by Kvadsheim et al. (2012) determined that while behavioral and physiological responses to sonar have the potential to result in bubble formation, the actually observed behavioral responses of cetaceans to sonar did not imply any significantly increased risk of over what may otherwise occur normally in individual marine mammals. By extension, no marine mammals addressed in this analysis are given differential treatment due to the possibility for acoustically mediated bubble growth.

3.4.3.1.2.2 Hearing Loss

The most familiar effect of exposure to high intensity sound is hearing loss, meaning an increase in the hearing threshold. The meaning of the term "hearing loss" does not equate to "deafness." This phenomenon associated with hearing loss is called a noise-induced threshold shift, or simply a threshold shift (Miller 1974). If high-intensity sound overstimulates tissues in the ear, causing a threshold shift, the impacted area of the ear (associated with and limited by the sound's frequency band) no longer provides the same auditory impulses to the brain as before the exposure (Ketten 2012). The distinction between permanent threshold shift (PTS) and temporary threshold shift (TTS) is based on whether there is complete recovery of a threshold shift following a sound exposure. If the threshold shift eventually returns to zero (the threshold returns to the pre-exposure value), the threshold shift is a TTS. The recovery to pre-exposure threshold from studies of marine mammals is usually on the order of minutes to hours for the small amounts of TTS induced (Finneran et al. 2005a; Nachtigall et al. 2004). The recovery time is related to the exposure duration, sound exposure level, and the magnitude of the threshold shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran et al. 2005a; Mooney et al. 2009a). In some cases, threshold shifts as large as 50 dB (loss in sensitivity) have been temporary, although recovery sometimes required as much as 30 days (Ketten 2012). If the threshold shift does not return to zero but leaves some finite amount of threshold shift, then that remaining threshold shift is a PTS. Again for clarity, PTS as discussed in this document is not a complete loss of hearing, but instead is the loss of hearing sensitivity over a particular range of frequencies. Figure 3.4-3 shows one hypothetical threshold shift that completely recovers, a TTS, and one that does not completely recover, leaving some PTS. The actual amount of threshold shift depends on the amplitude, duration, frequency, temporal pattern of the sound exposure, and on the susceptibility of the individual animal.



TTS: temporary threshold shift; TS: threshold shift; PTS: permanent threshold shift

Figure 3.4-3: Two Hypothetical Threshold Shifts

Although both auditory trauma and fatigue may result in hearing loss, the mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic fatigue and exhaustion of the hair cells and cochlear tissues. The term "auditory fatigue" is often used to mean "TTS"; however, in this analysis the Navy uses a more general meaning to differentiate between fatigue mechanisms (e.g., metabolic exhaustion and distortion of tissues) and trauma mechanisms (e.g., physical destruction of cochlear tissues occurring at the time of exposure).

Hearing loss due to auditory fatigue in marine mammals was studied by numerous investigators (Finneran et al. 2010a, b; Finneran et al. 2005a; Finneran and Schlundt 2010; Finneran et al. 2007; Finneran et al. 2000; Finneran et al. 2002; Kastak et al. 2007; Lucke et al. 2009; Mann et al. 2010; Mooney et al. 2009a; Mooney et al. 2009b; Nachtigall et al. 2003; Nachtigall et al. 2004; Popov et al. 2011; Schlundt et al. 2000; Southall et al. 2007). The studies of marine mammal auditory fatigue were all designed to determine relationships between TTS and exposure parameters such as level, duration, and frequency. In these studies, hearing thresholds were measured in trained marine mammals before and after exposure to intense sounds. The difference between the pre-exposure and post-exposure thresholds indicates the amount of TTS. Species studied include the bottlenose dolphin (total of nine individuals), beluga (2), harbor porpoise (1), finless porpoise (2), California sea lion (3), harbor seal (1), and northern elephant seal (1). Some of the more important data obtained from these studies are onset-TTS levels—exposure levels sufficient to cause a just-measurable amount of TTS, often defined as 6 dB of TTS (for example Schlundt et al. 2000).

Primary findings of the marine mammal TTS studies discussed above (unless otherwise cited) are:

- The growth and recovery of TTS are analogous to those in terrestrial mammals. This means that, as in terrestrial mammals, threshold shifts primarily depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure.
- The amount of TTS increases with exposure sound pressure level and the exposure duration.
- For continuous sounds, exposures of equal energy lead to approximately equal effects (Ward 1997). For intermittent sounds, less hearing loss occurs than from a continuous exposure with the same energy (some recovery will occur during the quiet period between exposures) (Kryter et al. 1965; Ward 1997).
- The Sound Exposure Level is correlated with the amount of TTS and is a good predictor for onset-TTS from single, continuous exposures with similar durations. This agrees with human TTS data presented by Ward et al. (1958; 1959a). However, for longer duration sounds, beyond 16–32 seconds, the relationship between TTS and sound exposure level breaks down, and duration becomes a more important contributor to TTS (Finneran et al. 2010a).
- The maximum TTS after tonal exposures occurs one-half to one octave above the exposure frequency (Finneran et al. 2007; Schlundt et al. 2000). Thus, TTS from tonal exposures can extend over a large (greater than one octave) frequency range.
- For bottlenose dolphins, non-impulsive sounds with frequencies above 10 kHz are more hazardous than those at lower frequencies (i.e., lower sound exposure levels required to affect hearing) (Finneran and Schlundt 2010).
- The amount of observed TTS tends to decrease at differing rates following noise exposure; however, the relationship is not monotonic. The amount of 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) require several days for recovery.
- TTS can accumulate across multiple intermittent exposures, but the resulting TTS will be less than the TTS from a single, continuous exposure with the same sound exposure level. This means that predictions based on total, cumulative sound exposure level will overestimate the amount of TTS from intermittent exposures.

Although there have been no marine mammal studies designed to measure PTS, the potential for PTS in marine mammals can be estimated based on known similarities between the inner ears of marine and terrestrial mammals. Experiments with marine mammals have revealed similarities to terrestrial mammals for features such as TTS, age-related hearing loss, ototoxic drug-induced hearing loss, masking, and frequency selectivity. Therefore, in the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated by assuming some upper limit of TTS that equates to the onset of PTS, then using TTS growth relationships from marine and terrestrial mammals to determine the exposure levels capable of producing this amount of TTS.

Hearing loss resulting from auditory fatigue could effectively reduce the distance over which animals can communicate, detect biologically relevant sounds such as predators, and echolocate (for odontocetes). The costs to marine mammals with TTS, or even some degree of PTS, have not been studied; however, it is likely that a relationship between the duration, magnitude, and frequency range of hearing loss could have consequences to biologically important activities (e.g., intraspecific communication, foraging, and predator detection) that affect survivability and reproduction.

3.4.3.1.2.3 Auditory Masking

As with hearing loss, auditory masking can effectively limit the distance over which a marine mammal can communicate, detect biologically relevant sounds, and echolocate (odontocetes). Unlike auditory fatigue, which always results in a localized stress response, behavioral changes resulting from auditory masking may not be coupled with a stress response. Another important distinction between masking and hearing loss is that masking only occurs in the presence of the sound stimulus, whereas hearing loss can persist after the stimulus is gone.

Critical ratios, the lowest ratio of signal-to-noise at which a signal can be detected, were determined for pinnipeds (Southall et al. 2000; Southall et al. 2003). Detections of signals under varying masking conditions were determined for active echolocation and passive listening tasks in odontocetes (Au and Pawloski 1989; Erbe 2000; Johnson 1971). These studies provide baseline information from which the probability of masking can be estimated. 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 in Stellwagen Bank National Marine Sanctuary, when two commercial vessels pass through a right whale’s optimal communication space (estimated as a sphere of water with a diameter of 10.8 nm [20 km]), that space is decreased by 84 percent. This method relies on empirical data on source levels of calls (which is unknown for many species) and requires many assumptions about ancient ambient noise conditions and simplifications of animal behavior, but it is an important step in determining the impact of anthropogenic noise on animal communication.

Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes to vocal behavior and call structure may result from a need to compensate for an increase in background noise. In cetaceans, vocalization changes were reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying.

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. 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). In contrast, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test, with transmissions centered at 57 Hz at up to 220 dB re: 1 µPa (Bowles et al. 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

Differential vocal responses in marine mammals were documented in the presence of seismic survey noise. An overall decrease in vocalization during active surveying was noted in large marine mammal groups (Potter et al. 2007), while blue whale feeding/social calls increased when seismic exploration was underway (Di Iorio and Clark 2010), indicative of a potentially compensatory response to the increased noise level. Melcon et al. (2012) recently documented that blue whales decreased the proportion of time spent producing certain types of calls when mid-frequency sonar was present. At present it is not known if these changes in vocal behavior corresponded to changes in foraging or any other behaviors.

Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. 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 for attending to and responding to all killer whale calls. The occurrence of masking or hearing impairment provides a means by which marine mammals may be prevented from responding to the acoustic cues produced by their predators. Whether this is a possibility depends on the duration of the masking/hearing impairment and the likelihood of encountering a predator during the time that predator cues are impeded.

3.4.3.1.2.4 Physiological Stress

Marine mammals 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, and interactions with predators all contribute to the stress a marine mammal experiences. In some cases, naturally occurring stressors can have profound impacts on marine mammals; for example, chronic stress, as observed in stranded animals with long-term debilitating conditions (e.g., disease), was demonstrated to result in an increased size of the adrenal glands and an increase in the number of epinephrine-producing cells (Clark et al. 2006). Anthropogenic activities have the potential to provide additional stressors beyond those that occur naturally.

Although sample sizes are small, the data collected to date suggest that different types of sounds potentially cause variable degrees of stress in marine mammals. Belugas demonstrated no catecholamine (hormones released in situations of stress) response to the playback of oil drilling sounds (Thomas et al. 1990b) but showed an 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 an elevation in aldosterone, a hormone suggested as being a significant indicator of stress in odontocetes (St. Aubin and Dierauf 2001; St. Aubin and Geraci 1989). Increases in heart rate were observed in bottlenose dolphins to which conspecific calls were played, although no increase in heart rate was observed when tank noise was played back (Miksis et al. 2001). A beluga's heart rate was observed to increase during exposure to noise, with increase dependent upon frequency band of noise and duration of exposure, with a sharp decrease to normal or below normal levels upon cessation of the exposure

(Lyamin et al. 2011). It is unknown how chronic exposure to acoustic stressors may affect marine mammals. Opportunistic comparison of levels of stress-related hormone metabolites in North Atlantic right whale feces collected before and after the tragic events of 11 September 2001 showed a decrease in metabolite levels corresponding to lower levels of ambient noise due to reduced ship traffic (Rolland et al. 2012). Collectively, these results suggest a variable response that depends on the characteristics of the received signal and prior experience with the received signal.

Other types of stressors include the presence of vessels, fishery interactions, acts of pursuit and capture, the act of stranding, and pollution. In contrast to the limited amount of work performed on stress responses resulting from sound exposure, a considerably larger body of work exists on stress responses associated with pursuit, capture, handling and stranding. Many cetaceans exhibit an apparent vulnerability in the face of these particular situations when taken to the extreme. A recent study compared pathological changes in organs/tissues of odontocetes stranded on beaches or captured in nets over a 40-year period (Cowan and Curry 2008). The type of changes observed indicate harm to multiple systems caused in part by an overload of catecholamines into the system, as well as a restriction in blood supply capable of causing tissue damage or tissue death. This extreme response to a major stressor(s) is thought to be mediated by the overactivation of the animal's normal physiological adaptations to diving or escape. Pursuit, capture, and short-term holding of belugas resulted in a decrease in thyroid hormones (St. Aubin and Geraci 1988) and increases in epinephrine (St. Aubin and Dierauf 2001). In bottlenose dolphins, the trend is more complicated with the duration of the handling time potentially contributing to the magnitude of the stress response (Ortiz and Worthy 2000; St. Aubin 2002; St. Aubin et al. 1996). Male gray seals subjected to capture and short-term restraint showed an increase in cortisol levels accompanied by an increase in testosterone (Lidgard et al. 2008). This result may be indicative of a compensatory response that enables the seal to maintain reproduction capability in spite of stress. Elephant seals demonstrate an acute cortisol response to handling but do not demonstrate a chronic response; on the contrary, adult females demonstrate a reduction in the adrenocortical response following repetitive chemical immobilization (Engelhard et al. 2002). Similarly, no correlation between cortisol levels and heart or respiration rate changes were seen in harbor porpoises during handling for satellite tagging (Eskesen et al. 2009). Taken together, these studies illustrate the wide variations in the level of response that can occur when faced with these stressors.

Factors to consider when trying to predict a stress or cueing response include the mammal's life history stage and whether they are naïve or experienced with the sound. Prior experience with a stressor may be of particular importance as repeated experience with a stressor may dull the stress response via acclimation (St. Aubin and Dierauf 2001).

The sound characteristics that correlate with specific stress responses in marine mammals are poorly understood. Therefore, in practice, a stress response is assumed if a physiological reaction such as a hearing loss or trauma is predicted; or if a significant behavioral response is predicted.

3.4.3.1.2.5 Behavioral Reactions

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 the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). The distance from the sound source and whether it is perceived as approaching or moving away can also affect the way an animal responds to a sound (Wartzok et al. 2003). For marine mammals, a review of responses to anthropogenic sound was first conducted by Richardson and others (1995). More recent reviews (Nowacek et al. 2007; Southall et al. 2007) address studies conducted since 1995 and focus on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated.

Except for some vocalization changes that may be compensating for auditory masking, all behavioral reactions are assumed to occur due to a preceding stress or cueing response; however, stress responses cannot be predicted directly due to a lack of scientific data (Section 3.4.3.1.2.4, Physiological Stress). Responses can overlap; for example, an increased respiration rate is likely to be coupled to a flight response. Differential responses between and within species are expected since hearing ranges vary across species and the behavioral ecologies of individual species are unlikely to completely overlap.

Southall et al. (2007) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions at specific sound levels. While in general, the louder the sound source the more intense the behavioral response, it was clear that the proximity of a sound source and the animal's experience, motivation, and conditioning were also critical factors influencing the response (Southall et al. 2007). After examining all of the available data, the authors felt that the derivation of thresholds for behavioral response based solely on exposure level was not supported because context of the animal at the time of sound exposure was an important factor in estimating response. Nonetheless, in some conditions, consistent avoidance reactions were noted at higher sound levels, depending on the marine mammal species or group, allowing conclusions to be drawn. Most low-frequency cetaceans (mysticetes) observed in studies usually avoided sound sources at levels of less than or equal to 160 dB re 1 µPa. Published studies of mid-frequency cetaceans analyzed include sperm whales, belugas, bottlenose dolphins, and river dolphins. These groups showed no clear tendency, but for non-impulsive sounds, captive animals tolerated levels in excess of 170 dB re 1 µPa before showing behavioral reactions, such as avoidance, erratic swimming, and attacking the test apparatus. High-frequency cetaceans (observed from studies with harbor porpoises) exhibited changes in respiration and avoidance behavior at levels between 90 and 140 dB re 1 µPa, with profound avoidance behavior noted for levels exceeding this. Phocid seals showed avoidance reactions at or below 190 dB re 1 µPa; thus, seals may actually receive levels adequate to produce TTS before avoiding the source. Recent studies with beaked whales have shown them to be particularly sensitive to noise, with animals during three playbacks of sound breaking off foraging dives at levels below 142 dB re 1 µPa sound pressure level, although acoustic monitoring during actual sonar exercises revealed some beaked whales continuing to forage at levels up to 157 dB re 1 µPa sound pressure level (Tyack et al. 2011).

<u>Behavioral Reactions to Impulsive Sound Sources</u>

Mysticetes

Baleen whales have shown a variety of responses to impulsive sound sources, including avoidance, reduced surface intervals, altered swimming behavior, and changes in vocalization rates (Gordon et al. 2003; Richardson et al. 1995; Southall et al. 2007). While most bowhead whales did not show active avoidance until within 8 km of seismic vessels (Richardson et al. 1995), some whales avoided vessels by more than 20 km at received levels as low as 120 dB re 1 µPa root mean square. Additionally, Malme et al. (1988) observed clear changes in diving and respiration patterns in bowheads at ranges up to 73 km from seismic vessels, with received levels as low as 125 dB re 1 µPa.

Gray whales migrating along the U.S. west coast showed avoidance responses to seismic vessels by 10 percent of animals at 164 dB re 1 µPa, and by 90 percent of animals at 190 dB re 1 µPa, with similar results for whales in the Bering Sea (Malme et al. 1988; Malme et al. 1986). In contrast, noise from seismic surveys was not found to impact feeding behavior or exhalation rates while resting or diving in western gray whales off the coast of Russia (Gailey et al. 2007; Yazvenko et al. 2007).

Humpback whales showed avoidance behavior at ranges of 5–8 km from a seismic array during observational studies and controlled exposure experiments in western Australia (McCauley et al. 1998). 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 and a shift to a higher incidence of net entanglement closer to the noise source.

Seismic pulses at average received levels of 131 dB re 1 µPa^{2}s caused blue whales to increase call production (Di lorio and Clark 2010). In contrast, 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). These studies demonstrate that even low levels of noise received far from the noise source can induce behavioral responses.

Odontocetes

Madsen et al. (2006) and Miller et al. (2009) tagged and monitored eight sperm whales in the Gulf of Mexico exposed to seismic airgun surveys. Sound sources were from approximately 2 to 7 nm away from the whales, and based on multipath propagation, received levels were as high as 162 dB SPL re 1 µPa with energy content greatest between 0.3 to 3.0 kHz (Madsen et al. 2006). The whales showed no horizontal avoidance, although the whale that was approached most closely had an extended resting period and did not resume foraging until the airguns had ceased firing (Miller et al. 2009). The remaining whales continued to execute foraging dives throughout exposure, however swimming movements during foraging dives were 6 percent lower during exposure than control periods, suggesting subtle effects of noise on foraging behavior (Miller 2009).

Captive bottlenose dolphins sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al. 2002).

Pinnipeds

A review of behavioral reactions by pinnipeds to impulsive noise can be found in (Richardson et al. 1995; 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 root mean square 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 root mean square (Finneran et al. 2003c).

Experimentally, Götz and 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 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.

Behavioral Reactions to Sonar and other Active Acoustic Sources

Mysticetes

Specific to U.S. Navy systems using low-frequency sound, studies were undertaken in 1997–98 pursuant to the Navy's Low-Frequency Sound Scientific Research Program. These studies found only short-term responses to low frequency sound by mysticetes (fin, blue, and humpback whales), including changes in vocal activity and avoidance of the source vessel (Clark and Fristrup 2001; Croll et al. 2001; Fristrup et al. 2003; Miller et al. 2000; Nowacek et al. 2007). Baleen whales exposed to moderate low-frequency signals demonstrated no variation in foraging activity (Croll et al. 2001).

Five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives, although the alarm signal was long in duration, lasting several minutes, and 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 received sound pressure level was similar in the Croll et al. and Nowacek et al. studies (133–150 dB re 1 µPa sound pressure level), the frequency, duration, and temporal pattern of signal presentation were different. Additionally, the right whales did not respond to playbacks of either right whale social sounds or vessel noise, highlighting the importance of the sound characteristics, species differences, and individual sensitivity in producing a behavioral reaction.

Low-frequency signals of the Acoustic Thermometry of Ocean Climate sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark 2000). 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.

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 (Melcón et al. 2012). It is not known whether the lower rates of calling actually indicated a reduction in feeding behavior or social contact since the study used data from remotely deployed, passive acoustic monitoring buoys. In contrast, blue whales increased their likelihood of calling when ship noise was present and decreased their likelihood of calling in the presence of explosive noise, although this result was not statistically significant (Melcón et al. 2012). Additionally, the likelihood of an animal calling decreased with the increased received level of mid-frequency sonar, beginning at a sound pressure level of approximately 110 to 120 dB re 1 µPa (Melcón et al. 2012). Blue whales responded to a mid-frequency sound source, with a source level between 160-210 dB re 1 µPa at 1 m and a received sound level up to 160 dB re 1 µPa, by exhibiting generalized avoidance responses and changes to dive behavior during controlled exposure experiments (Goldbogen et al. 2013). However, reactions were not consistent across individuals based on received sound levels alone, and likely were the result of a complex interaction between sound exposure factors such as proximity to sound source and sound type (mid-frequency sonar simulation vs. pseudo-random noise), environmental conditions, and behavioral state. Surface feeding whales did not show a change in behavior during controlled exposure experiments, but deep feeding and non-feeding whales showed temporary reactions that quickly abated after sound exposure. Distances of the sound source from the whales during controlled exposure experiments were sometimes less than a mile. These preliminary findings from Melcón et al. (2012) and Goldbogen et al. (2013) are consistent with the Navy's criteria and thresholds for predicting behavioral effects to mysticetes (including blue whales) from sonar and other active acoustic sources used in the quantitative acoustic effects analysis (see Section 3.4.3.1.5, Quantitative Analysis below). The behavioral risk function predicts a probability of a substantive behavioral reaction for individuals exposed to a received sound pressure level of 120 dB re 1µPa or greater, with an increasing probability of reaction with increased received level as demonstrated in Melcón et al. (2012).

Odontocetes

From 2007 to 2011, behavioral response studies were conducted through the collaboration of various research organizations in the Bahamas, Southern California, the Mediterranean, Cape Hatteras, and Norwegian waters. These studies attempted to define and measure responses of beaked whales and other cetaceans to controlled exposures of sonar and other sounds to better understand their potential impacts. Results from the 2007–2008 study conducted near the Bahamas showed a change in diving behavior of an adult Blainville's beaked whale to playback of mid-frequency source and predator sounds (Boyd et al. 2008; Tyack et al. 2011). Reaction to mid-frequency sounds included premature cessation of clicking and termination of a foraging dive, and a slower ascent rate to the surface. Preliminary results from a similar behavioral response study in southern California waters have been presented for the 2010–2011 field season. De Ruiter et al. (2013) presented results from two Cuvier's beaked whales that were tagged and exposed to simulated mid-frequency active sonar during the 2010 and 2011 field seasons of the southern California behavioral response study. The 2011 whale was also incidentally exposed to mid-frequency active sonar from a distant naval exercise. 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 root mean squared, respectively. Both whales showed responses to the controlled exposures, ranging from initial orientation changes to avoidance responses characterized by energetic fluking and swimming away from the source. However, the authors did not detect similar responses to incidental exposure to distant naval sonar exercises at comparable received levels, indicating that context of the exposures (e.g., source proximity, controlled source ramp-up) may have been a significant factor. Cuvier's beaked whale responses suggested particular sensitivity to sound exposure as consistent with results for Blainville's beaked whale. Similarly, beaked whales exposed to sonar during British training exercises stopped foraging (Defense Science Technology Laboratory 2007), and preliminary results of controlled playback of sonar may indicate feeding/foraging disruption of killer whales and sperm whales (Miller et al. 2011).

In the 2007–2008 Bahamas study, playback sounds of a potential predator—a killer whale—resulted in a similar but more pronounced reaction, which included longer inter-dive intervals and a sustained straight-line departure of more than 20 km from the area. The authors noted, however, that the magnified reaction to the predator sounds could represent a cumulative effect of exposure to the two sound types since killer whale playback began approximately two hours after mid-frequency source playback. Pilot whales and killer whales off Norway also exhibited horizontal avoidance of a transducer with outputs in the mid-frequency range (signals in the 1 kHz – 2 kHz and 6 kHz – 7 kHz ranges) (Miller et al. 2011). Additionally, separation of a calf from its group during exposure to mid-frequency sonar playback was observed (Miller et al. 2011). In contrast, preliminary analyses suggest that none of the pilot whales or false killer whales in the Bahamas showed an avoidance response to controlled exposure playbacks (Southall et al. 2009).

Through analysis of the behavioral response studies, a preliminary overarching effect of greater sensitivity to all anthropogenic exposures was seen in beaked whales compared to the other odontocetes studied (Southall et al. 2009). Therefore, recent studies have focused specifically on beaked whale responses to active sonar transmissions or controlled exposure playback of simulated sonar on various military ranges (Claridge and Durban 2009; Defence Science and Technology Laboratory 2007; McCarthy et al. 2011; Moretti et al. 2009; Tyack et al. 2011). In the Bahamas, Blainville's beaked whales located on the range will move off-range during sonar use and return only after the sonar transmissions have stopped, sometimes taking several days to do so (Claridge and Durban 2009; McCarthy et al. 2011; Moretti et al. 2009; Tyack et al. 2011).

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 (National Marine Fisheries Service (Office of Protected Resources) Fromm 2009; 2005; U.S. Department of the Navy 2003) estimated a mean received sound pressure level of approximately 169.3 dB re 1µPa at the location of the killer whales at the closest point of approach between the animals and the vessel (estimated sound pressure levels ranged from 150 to 180 dB re 1µPa).

Research on sperm whales near the Grenadines (Caribbean) in 1983 coincided with the U.S. intervention in Grenada, where animals were observed scattering and leaving the area in the presence of military sonar, presumably from nearby submarines (Watkins et al. 1985; Watkins and Schevill 1975). The authors did not report received levels from these exposures and reported similar reactions from noise generated by banging on their boat hull. It was unclear if the sperm whales were reacting to the sonar signal itself or to a potentially new unknown sound in general. Additionally, sperm whales In the Caribbean stopped vocalizing when presented with sounds from nearby acoustic pingers (Watkins and Schevill 1975).

Researchers at the Navy's Marine Mammal Program facility in San Diego, California have conducted a series of controlled experiments on bottlenose dolphins and beluga whales to study TTS (Finneran et al. 2003a; Finneran et al. 2001; Finneran et al. 2005a; Finneran and Schlundt 2004; Schlundt et al. 2000). Ancillary to the TTS studies, scientists evaluated whether the marine mammals performed their trained tasks when prompted, during and after exposure to mid-frequency tones. Altered behavior during experimental trials usually involved refusal of animals to return to the site 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). 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 root mean square, 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 these studies were generally not designed to test avoidance behavior and animals were commonly reinforced with food, the controlled environment and ability to measure received levels provide insight on received levels at which animals will behaviorally responds to noise sources.

Studies with captive harbor porpoises showed increased respiration rates upon introduction of 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) and emissions for underwater data transmission (Kastelein et al. 2005c). However, exposure of the same acoustic alarm 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.

Pinnipeds

Different responses displayed by captive and wild phocid seals to sound judged to be “unpleasant” have been reported; where captive seals habituated (did not avoid the sound), and wild seals showed avoidance behavior (Götz and 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 habituates to novel or unpleasant sounds. Another study found that captive hooded seals reacted to 1–7 kHz sonar signals, in part with displacement to the areas of least sound pressure level, at levels between 160 and 170 dB re 1 µPa (Kvadsheim et al. 2010). Low-frequency signals of the Acoustic Thermometry of Ocean Climate sound source were not found to overtly affect elephant seal dives (Costa et al. 2003).

Captive studies with other pinnipeds have shown a reduction in dive times when presented with qualitatively unpleasant sounds. These studies indicated that the subjective interpretation of the pleasantness of a sound, minus the more commonly studied factors of received sound level and sounds associated with biological significance, can affect diving behavior (Götz and Janik 2010).

Behavioral Reactions to Vessels

Navy vessels are a small component of overall vessel traffic and vessel noise in areas where they operate. Data presented by the Center for Navy Analysis (Mintz and Filadelfo 2011) show that Navy vessel-hours constitute approximately 6 to 7 percent of large vessel-hours in the U.S. Exclusive Economic Zone and small percentages even within Navy concentration areas such as the range complexes (i.e., Virginia Capes [VACAPES], Hawaii, Southern California). In addition, Navy combatant vessels have been designed to generate minimal noise and use ship quieting technology to elude detection by enemy passive acoustic devices (Mintz and Filadelfo 2011; Southall 2005). Navy ships do not purposefully approach or follow marine mammals and are generally not expected to elicit avoidance or alarm behavior, except for sensitive species (e.g., harbor porpoises and beaked whales). Additionally, smaller Navy vessels that operate in inshore waters are expressly prohibited from approaching or following marine mammals.

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 and Wright 2007; Hildebrand 2005; Richardson et al. 1995). 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 2009; Tyack et al. 2011). 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 and Crosti 2009; Au and Green 2000; Christiansen et al. 2010; Erbe 2002; Noren et al. 2009; Stockin et al. 2008; Williams et al. 2009). Most studies examined the short-term response to vessel sound and vessel traffic (Magalhães et al. 2002; Richardson et al. 1995; Watkins 1981); however, the long-term and cumulative implications of ship sound on marine mammals is largely unknown (National Marine Fisheries Service 2007). Clark et al. (2009) provided a discussion on calculating the cumulative impacts of anthropogenic noise on baleen whales (see Section 3.4.3.1.2.3, Auditory Masking, for further discussion on this topic).

Mysticetes

Fin whales may alter their swimming patterns by increasing speed and heading away from the vessel, as well as changing their breathing patterns in response to a vessel approach (Jahoda et al. 2003). Vessels that remained 328 ft. (100 m) or farther from fin and humpback whales were largely ignored in one study in an area where whale watching activities are common (Watkins 1981). Only when vessels approached more closely did the fin whales in this study alter their behavior by increasing time at the surface and exhibiting avoidance behaviors. Other studies have shown when vessels are near, some but not all fin whales change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions (Au and Green 2000; Richter et al. 2003; Williams et al. 2002a).

Based on passive acoustic recordings and in the presence of sounds from passing vessels, Melcon et al. (2012) reported that blue whales had an increased likelihood of producing certain types of calls. At present it is not known if these changes in vocal behavior corresponded to changes in foraging or any other behaviors. In the Watkins (1981) study, humpback whales did not exhibit any avoidance behavior but did react to vessel presence. In a study of regional vessel traffic, (Baker et al. 1983) found that when vessels were in the area, the respiration patterns of the humpback whales changed. The whales also exhibited two forms of behavioral avoidance: horizontal avoidance (changing direction or speed) when vessels were between 1.24 and 2.48 mi. (2,000 m and 4,000 m) away, and vertical avoidance (increased dive times and change in diving pattern) when vessels were less than 1.24 mi. (2,000 m) away (Baker et al. 1983). Similarly, when approached by whale watching vessels in Hawaii, humpback whales responded by increasing swim speed, changing direction to avoid, and staying submerged for longer periods of time (Au and Green 2000). Recently, Gende et al. (2011) reported on observations of humpback whales in inland waters of Southeast Alaska subjected to frequent cruise ship transits (i.e., in excess of 400 transits in a 4-month season in 2009). The study was focused on determining if close encounter distance was a function of vessel speed. The reported observations, however, seem in conflict with other reports of avoidance at much greater distance so it may be that humpback whales in those waters are more tolerant of vessels (given their frequency) or are engaged in behaviors, such as feeding, that they are less willing to abandon. This example again highlights that context is critical for predicting and understanding behavioral reactions as concluded by Southall et al. (2007). Navy vessels avoid approaching large whales head on and maneuver to maintain a mitigation zone of 500 yd. (457.2 m) around observed large whales.

Sei whales have been observed ignoring the presence of vessels and passing close to the vessel (National Marine Fisheries Service 1998). 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. 2009). 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).

North Atlantic right whales tend not to respond to the sounds of oncoming vessels (Nowacek et al. 2004a) 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 (Nowacek et al. 2004a; Terhune and Verboom 1999). Although this may minimize potential disturbance from passing ships, it does increase the whales' vulnerability to potential ship strike. The regulated approach distance for right whales is 500 yd. (457 m) (FR 62 (30): 6729-6738, February 13, 1997).

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 (ignoring) reactions allowing boats to approach within 98.4 ft. (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).

Mysticetes have been shown to both increase and decrease calling behavior in the presence of vessel noise. 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 has been noted near Brazil due to boat traffic (Sousa-Lima and Clark 2008).

Odontocetes

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; Wursig et al. 1998). One study showed that after diving, sperm whales showed a reduced timeframe from when they emitted the first click than before vessel interaction (Richter et al. 2006). The 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 the individual whale. Most *Kogia* species and beaked whales react negatively to vessels by quick diving and other avoidance maneuvers (Wursig et al. 1998). Reactions to Navy vessels are not well documented, but smaller whale watching and research boats have been shown to cause these species to alter their breathing intervals and echolocation patterns.

Very little information is available on the behavioral impacts of vessels or vessel noise on beaked whales (Cox et al. 2006). However, a single observation of vocal disruption of a foraging dive by a tagged Cuvier's beaked whale was documented when a large noisy vessel was present, suggesting that vessel noise 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.

Most delphinids react neutrally to vessels, although both avoidance and attraction behavior have been observed (Hewitt 1985; Wursig et al. 1998). Avoidance reactions include a decrease in resting behavior or change in travel direction (Bejder et al. 2006b). Incidents of attraction includes common, rough-toothed, and bottlenose dolphins bow riding and jumping in the wake of a vessel (Norris and Prescott 1961; Ritter 2002; Shane et al. 1986; Wursig 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).

Killer whales, the largest of the dolphins (family Delphinidae), are targeted by numerous small whale-watching vessels in the Pacific Northwest. These vessels have source levels that range from 145 to 169 dB re 1 µPa at 1 m and have the potential to result in behavioral disturbance, interfere with communication, and affect the killer whales' hearing (Erbe 2002). Killer whales foraged significantly less and traveled significantly more when boats were within 328 ft. (100 m) of the whales (Kruse 1991; Lusseau et al. 2009; Trites and Bain 2000; Williams et al. 2002a; Williams et al. 2009; Williams et al. 2002b). These short-term feeding activity disruptions may have important long-term population-level effects (Lusseau et al. 2009; Noren et al. 2009). 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. For inland waters of Washington state, regulations were promulgated in 2011 for commercial and private vessels, restricting approach to within 200 yd. (182.9 m) of killer whales, although these regulations were specifically developed to protect the endangered southern resident killer whales (FR 76 (72): 20870-20890, April 14, 2011). As stated previously, Navy mitigation measures are more protective, with a 500 yd. (457.2 m) avoidance zone of all sighted whales.

Similar behavioral changes (increases in traveling and other stress-related behaviors) have been documented in Indo-Pacific bottlenose dolphins in Zanzibar (Christiansen et al. 2010; Englund and Berggren 2002; Stensland and Berggren 2007). Short-term displacement of dolphins due to tourist boat presence has been documented (Carrera et al. 2008), while longer term or repetitive/sustained displacement for some dolphin groups due to chronic vessel noise has been noted (Haviland-Howell et al. 2007). 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 and Crosti 2009; Berrow and Holmes 1999; Gregory and Rowden 2001; Janik and Thompson 1996; Lusseau 2004; Mattson et al. 2005; Scarpaci et al. 2000).

Indo-Pacific humpback dolphins have been observed to dive for longer periods in areas where vessels were present or approaching (Ng and Leung 2003). 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 and Leung 2003).

Both finless porpoises (Li et al. 2008) and harbor porpoises (Polacheck and Thorpe 1990) routinely avoid and swim away from large motorized vessels. The vaquita, which is closely related to the harbor porpoise in the Study Area, appears to avoid large vessels at about 2,995 ft. (913 m) (Jaramillo-Legorreta et al. 1999). The assumption is that the harbor porpoise would respond similarly to large Navy vessels.

Odontocetes have been shown to make short-term changes to vocal parameters such as intensity (Holt et al. 2008) as an immediate response to vessel noise, as well as increase the pitch, frequency modulation, and length of whistling (May-Collado and Wartzok 2008). 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).

Pinnipeds

Little is known about pinniped reactions to underwater non-impulsive sounds (Southall et al. 2007) including vessel noise. In a review of reports on reactions of pinnipeds to small craft and ships, Richardson et al. (1995) noted that information on pinniped reactions is limited and most reports are based on anecdotal observations. Specific case reports in Richardson et al. (1995) 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. (Southall et al. 2007), pinniped responses to vessels are affected by the context of the situation and by the animal's experience. In summary, 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. 1995).

A 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 1,640 ft. (500 m) and four times more likely when the cruise ship approaches within 328 ft. (100 m) (Jansen et al. 2010). Navy vessels would generally not operate in vicinity of nearshore natural areas that are pinniped haul-out or rookery locations.

Manatees

The West Indian manatee responds to vessel movement via acoustic and possibly visual cues by moving away from the approaching vessel, increasing its swimming speed, and moving toward deeper water (Miksis-Olds et al. 2007; Nowacek et al. 2004b). The degree of response varies with the individual manatee and may be more pronounced in deeper water, where they are more easily able to locate the direction of the approaching vessel (Nowacek et al. 2004b). This disturbance is a temporary response to the approaching vessel. West Indian manatees have also been shown to seek out areas with a lower density of vessels (Buckingham et al. 1999). West Indian manatees exhibit a clear behavioral response to vessels within distances of 82 to 164 ft. (25 to 50 m), but it is unclear at what distance the manatees first detect the presence of vessels (Nowacek et al. 2004b). Vessel traffic and recreation activities that disturb West Indian manatees may cause them to leave preferred habitats and may alter biologically important behaviors, such as feeding, suckling, or resting (Haubold et al. 2006).

In manatees, call rates and call amplitude were affected by noise that shared dominant frequencies of watercraft, with rates decreasing during feeding/socializing, and differential effects seen on call type based on the presence/absence of calves (Miksis-Olds and Tyack 2009). These changes in vocalizations varied with the frequency of the noise, the type of call being produced, and the behavioral/social context; taken together, these changes may indicate that responses are dependent on behavioral and environmental contexts to vessel noise.

Behavioral Reactions to Aircraft and Missile Overflights

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. Thorough reviews of the subject and available information is presented in Richardson et al. (1995) and Luksenburg and Parsons (2009) (Efroymson et al. 2001; Holst et al. 2011). 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. (1995) 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. 1995). These factors could include aircraft type (single engine, multi-engine, jet turbine), flight path (centered on the animal, off to one side, circling, level and slow), environmental factors such as wind speed, sea state, cloud cover, and locations where native subsistence hunting continues.

Mysticetes

Mysticetes either ignore or occasionally dive in response to aircraft overflights (Efroymson et al. 2001; Koski et al. 1998). Richardson et al. (1985; Richardson et al. 1995) reported that while data on the reactions of mysticetes are meager and largely anecdotal, there is no evidence that single or occasional aircraft flying above mysticetes causes long-term displacement of these mammals. In general, overflights above 1,000 ft. (304.8 m) do not cause a reaction and National Oceanic and Atmospheric Administration has promulgated a regulation for Hawaiian waters and the Hawaii Humpback Whale National Marine Sanctuary adopting this stand-off distance (FR 64 (228): 66566-66579, November 29, 1999). For right whales, the stand-off distance for aircraft is 500 yd. (427 m) (FR 62 (30): 6729-6738, February 13, 1997).

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 492 ft. (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 native Alaskans, which could lead to animals developing additional sensitivity to human noise and presence.

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. 1995).

During standard marine mammal surveys at an altitude of 750 ft., some sperm whales remained on or near the surface the entire time the aircraft was in the vicinity, while others dove immediately or a few minutes after being sighted. Other authors have corroborated the variability in sperm whales' reactions to fixed-wing aircraft or helicopters (Green et al. 1992; Richter et al. 2006; Richter et al. 2003; Smultea et al. 2008a; Wursig 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. 1995). 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. 2008b; Smultea et al. 2001). Whale-watching aircraft 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).

Navy aircraft do not hover over or fly at low altitude to follow whales and so are not expected to evoke this type of response.

Smaller delphinids generally react to overflights either neutrally or with a startle response (Wursig et al. 1998). The same species that show strong avoidance behavior to vessel traffic (*Kogia* species and beaked whales) show similar reactions to aircraft (Wursig 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 492 ft. (150 m).

Pinnipeds

Richardson et al. (1995) noted that data on pinniped reactions to aircraft overflight largely consisted of opportunistic and anecdotal observations. The summary by Richardson et al. (1995) of this variable data noted that responsiveness generally was dependent on the altitude of the aircraft, the abruptness of the associated aircraft sound, and life cycle stage (breeding, molting, etc.). Hauled out pinnipeds exposed to aircraft sight and sound reacted by becoming alert and in many cases rushing into the water. Stampedes resulting in mortality to pups (by separation or crushing) have been noted in some cases, although it is rare (Holst et al. 2011).

Reactions of walruses on land varied in severity and included minor head raising at a distance of 8,200 ft. (2.5 km), orienting toward or entering the water at less than 492 ft. and 4,270 ft. in altitude (less than 150 m and 1.3 km), to full flight reactions at horizontal ranges of less than 3,280 ft. (1 km) at altitudes as high as 3,280- 4,920 ft. (1,000–1,500 m)(Richardson et al. 1995). It was noted that adult females, calves and juveniles were more likely to enter the water than males and that stampedes can result when disturbance is severe. Alternatively, some herds may habituate to overflights. Reactions of walruses at sea or on pack ice varied but included avoidance behaviors such as rapid diving and leaving the ice.

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 and Børset 1992), although they have been known to elicit behavioral reactions such as fleeing (Hoover 1988). In other studies, harbor seals showed no reaction to helicopter overflights (Gjertz and Børset 1992).

Ringed seals near an oil production island in Alaska reacted to approaching Bell 212 helicopters generally by increasing vigilance, although one seal left its basking site for the water after a helicopter approached within approximately 328 ft. (100 m) (Blackwell et al. 2004). Seals near the oil production platform were thought to be habituated and showed no reactions to industrial noise in water or in air, including impact pipe-driving, during the rest of the observations.

For California sea lions and Steller sea lions at a rocky haulout off Crescent City in northern California, helicopter approach to landing typically caused the most severe response (National Marine Fisheries Services 2010). Responses were also dependent on the species with Steller sea lions being more "skittish" and California sea lions more tolerant. Depending on the spacing between subsequent approaches, animals hauled out in between and fewer animals reacted upon subsequent exposures (National Marine Fisheries Services 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 2.5 mi. (4 km) of the rocket trajectory leaving their haul-out 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).

Manatees

There are few data on the effects of aircraft overflight on the West Indian manatee. Rathbun studied the reaction of West Indian manatees to both fixed-wing aircraft and helicopters used during census surveys (Rathbun 1988). The manatees did not react to a fixed-wing aircraft moving at approximately 81 miles per hour (mph) (130 kilometers per hour [km/h]) at 525 ft. altitude; however, animals did react to a helicopter below approximately 328 ft. moving at speeds of 0 (hovering) to 12.4 mph (0 to 20 km/h) by startling from rest and diving to deeper waters.

3.4.3.1.2.6 Repeated Exposures

Repeated exposures of an individual to multiple sound-producing activities over a season, year, or life stage could cause reactions with costs that can accumulate over time to cause long-term consequences for the individual. Conversely, some animals habituate to or become tolerant of repeated exposures over time, learning to ignore a stimulus that in the past has not accompanied any overt threat.

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.

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. Marine mammals that are more tolerant may stay in a disturbed area, whereas individuals that are more sensitive may leave for areas with less human disturbance. However, animals that remain in the area throughout the disturbance may be unable to leave the area for a variety of physiological or environmental reasons. Terrestrial examples of this abound as human disturbance and development displace more sensitive species, and tolerant animals move in to exploit the freed resources and fringe habitat. Longer-term displacement can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the sound (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. Whales did repopulate the lagoon after shipping activities had ceased for several years (Bryant et al. 1984). Over a shorter time scale, 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, and that individuals may move off of the range for several days during and following a sonar event. However animals are thought to continue feeding at short distances (a few kilometers) from the range out of the louder sound fields (less than 157 dB re 1 µPa) (McCarthy et al. 2011; Tyack et al. 2011). Mysticetes in the northeast tended to adjust to vessel traffic over a number 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. Nevertheless, the long-term consequences of these habitat utilization changes are unknown, and likely vary depending on the species, geographic areas, and the degree of acoustic or other human disturbance.

Moore and Barlow (2013) have noted a decline in beaked whales in a broad area of the Pacific Ocean area out to 300 nm from the coast and extending from the Canadian-U.S. border to the tip of Baja Mexico. There are scientific caveats and limitations to the data used for that analysis, as well as oceanographic and species assemblage changes not thoroughly addressed in Moore and Barlow (2013), although the authors suggest Navy sonar as one possible explanation for the apparent decline in beaked whale numbers over that broad area. In the small portion of the Pacific coast overlapping the Navy's Southern California Range Complex, long-term residency by individual Cuvier's beaked whales and documented higher densities of beaked whales provide indications that the proposed decline in numbers elsewhere along the Pacific coast is not apparent where the Navy has been intensively training and testing with sonar and other systems for decades. While it is possible that a downward trend in beaked whales may have gone unnoticed at the range complex (due to a lack of survey precision) or that beaked whale densities may have been higher before the Navy began using sonar more than 60 years ago, there is no data available to suggest that beaked whale numbers have declined on the range where Navy sonar use has routinely occurred. As Moore and Barlow (2013) point out, it remains clear that the Navy range in Southern California continues to support high densities of beaked whales.

3.4.3.1.2.7 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 and Lounsbury 2005; Perrin and Geraci 2002). Animals outside of their "normal" habitat are also sometimes considered "stranded" even though they may not have beached themselves. Under U.S. law, a stranding is an event in the wild that: (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 United States Code [U.S.C.] § 1421h).

Marine mammals are subjected to a variety of natural and anthropogenic factors, acting alone or in combination, which may cause a marine mammal to strand (Geraci et al. 1999; Geraci and Lounsbury 2005). Even for the fractions of more thoroughly investigated strandings involving post-stranding data collection and necropsies, the cause (or causes) for the majority of strandings remain undetermined. Natural factors related to strandings include, for example, the availability of food, predation, disease, parasitism, climatic influences, and aging (Bradshaw et al. 2006; Culik 2002; Geraci et al. 1999; Geraci and Lounsbury 2005; Hoelzel 2002; National Research Council 2006; Perrin and Geraci 2002; Walker et al. 2005). Anthropogenic factors include, for example, pollution (Elfes et al. 2010; Hall et al. 2006a; Hall et al. 2006b; Jepson et al. 2005; Marine Mammal Commission 2010; Tabuchi et al. 2006), vessel strike (Berman-Kowalewski et al. 2010; de Stephanis and Urquiola 2006; Geraci and Lounsbury 2005; Jensen and Silber 2004; Laist et al. 2001), fisheries interactions (Read et al. 2006), entanglement (Baird and

Gorgone 2005; Saez et al. 2012), and noise (Cox et al. 2006; National Research Council 2003; Richardson et al. 1995).

Along the coasts of the continental United States and Alaska between 2001 and 2009, there were on average approximately 1,400 cetacean strandings and 4,300 pinniped strandings (5,700 total) per year (National Marine Fisheries Service 2011). Several mass strandings (strandings that involve two or more individuals of the same species, excluding a single cow-calf pair) that have occurred over the past two decades have been associated with naval operations, seismic surveys, and other anthropogenic activities that introduced sound into the marine environment. 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 2013a).

Sonar use during exercises involving U.S. Navy (most often in association with other nations' defense forces) 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 (Marine Mammal Commission 2006b). These five mass strandings have resulted in about 40 known, scientifically verifiable sonar-related deaths among cetaceans consisting mostly of beaked whales (International Council for the Exploration of the Seas 2005).

In these circumstances, exposure to non-impulsive acoustic energy has been considered a potential indirect cause of the death of marine mammals (Cox et al. 2006). One hypothesis is that strandings may result from tissue damage caused by "gas and fat embolic syndrome" (Fernández et al. 2005; Jepson et al. 2003; Jepson et al. 2005). Models of nitrogen saturation in diving marine mammals have been used to suggest that altered dive behavior might result in the accumulation of nitrogen gas such that the potential for nitrogen bubble formation is increased (Houser et al. 2001; Zimmer and Tyack 2007). If so, this mechanism might explain the findings of gas and bubble emboli in stranded beaked whales. It is also possible that stranding is a behavioral response to a sound under certain conditions and that the subsequently observed physiological effects (e.g., overheating, decomposition, or internal hemorrhaging from being on shore) were the result of the stranding rather than a direct physical impact from exposure to sonar (Cox et al. 2006).

As the International Council for the Exploration of the Sea (2005) noted, taken in context of marine mammal populations in general, sonar is not a major threat or a significant portion of the overall ocean noise budget. This has also been demonstrated by monitoring in areas where the Navy operates (Bassett et al. 2010; Baumann-Pickering et al. 2010; McDonald et al. 2006; Tyack et al. 2011). Regardless of the direct cause of strandings, the Navy considers potential sonar related strandings important and continues to fund research and work with scientists to better understand circumstances that may result in strandings.

During a Navy training event on 4 March 2011 at the Silver Strand Training Complex in San Diego, California, three or possibly four dolphins were killed in an explosion. During an underwater detonation training event, a pod of 100–150 long-beaked common dolphins were observed moving towards the 700-yard (640-m) exclusion zone around the explosive charge, monitored by personnel in a safety boat and participants in a dive boat. Approximately five minutes remained on a time-delay fuse connected to a single 8.76 lb. explosive charge (C-4 and detonation cord). 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 and three long-beaked common dolphins near the explosion died. In addition to the three dolphins found dead on 4 March 2011 at the event site, the remains of a fourth dolphin, with injuries consistent with blast injury, were discovered on 7 March 2011 near Oceanside, California (3 days later and approximately 42.3 mi. (68.1 km) from Silver Strand where the training event occurred), which might also have been related to this event (Danil and St. Ledger 2011). Association of the fourth stranding with the training event is uncertain because dolphins strand on a regular basis in the San Diego area. Details such as the dolphins' depth and distance from the explosive at the time of the detonation could not be estimated from the 250 yard (228.6 m) standoff point of the observers in the dive boat or the safety boat.

These dolphin mortalities are the only known occurrence of a U.S. Navy training or testing event involving impulse energy (underwater detonation) that caused mortality or injury to a marine mammal. Despite this being a rare occurrence, Navy has reviewed training requirements, safety procedures, and possible mitigation measures and implemented changes to reduce the potential for this to occur in the future. Discussions of procedures associated with these and other training and testing events are presented in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring), which details all mitigations.

In comparison to potential strandings or injury resulting from events associated with Navy activities, marine mammal strandings and injury from commercial vessel ship strike (Berman-Kowalewski et al. 2010), impacts from urban pollution (Murata et al. 2008), and annual fishery-related bycatch (Baird and Gorgone 2005; Forney and Kobayashi 2007; Saez et al. 2012) have been estimated to be orders of magnitude greater (hundreds of thousands of animals versus tens of animals) (Culik 2002; International Council for the Exploration of the Sea 2005; Read et al. 2006). This does not negate the potential influence of mortality or additional stressors to small, regionalized sub-populations that may be at greater risk from human related impacts (fishing, vessel strike, and sound) than populations with larger distributions.

3.4.3.1.3 Long-Term Consequences to the Individual and the Population

Long-term consequences to a population are determined by examining changes in the population growth rate. Individual effects that could lead to a reduction in the population growth rate include mortality or injury (that removes animals from the reproductive pool), hearing loss (which depending on severity could impact navigation, foraging, predator avoidance, or communication), chronic stress (which could make individuals more susceptible to disease), displacement of individuals (especially from preferred foraging or mating grounds), and disruption of social bonds (due to masking of conspecific signals or displacement) (Section 3.0.5.7.1.1, Flowchart). However, the long-term consequences of any of these effects are difficult to predict because individual experience and time can create complex contingencies, especially for intelligent, long-lived animals like marine mammals. While a lost reproductive opportunity could be a measureable cost to the individual, the outcome for the animal, and ultimately the population, can range from insignificant to significant. Any number of factors, such as maternal inexperience, years of poor food supply, or predator pressure, could produce a cost of a lost reproductive opportunity, but these events may be "made up" during the life of a normal healthy individual. The same holds true for exposure to human-generated sound sources. These biological realities must be taken into consideration when assessing risk, uncertainties about that risk, and the feasibility of preventing or recouping such risks. All too often, the long-term consequence of relatively trivial events like short-term masking of a conspecific's social sounds, or a single lost feeding opportunity, is exaggerated beyond its actual importance by focus on the single event and not the important variable, which is the individual and its lifetime parameters of growth, reproduction, and survival.

The linkage between a stressor such as sound and its immediate behavioral or physiological consequences for the individual, and then the subsequent effects on that individual's vital rates (growth, survival, and reproduction), and the consequences, in turn, for the population have been reviewed in National Research Council (2005). The Population Consequences of Acoustic Disturbance model (National Research Council 2005) proposes a quantitative method 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. 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. The time-scale of the inputs in a population model for long-lived animals such as marine mammals is on the order of seasons, years, or life stages (e.g., neonate, juvenile, reproductive adult), and are often concerned only with the success of individuals from one time period or stage to the next. Unfortunately, for acoustic and explosive impacts on marine mammal populations, many of the inputs required by population models are not known.

The best assessment of long-term consequences from training and testing activities will be to monitor the populations over time within the Study Area. A recent 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 monitoring plans for protected marine mammals and sea turtles 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 current mitigation practices (see Section 3.0.2.2.2, Monitoring During Training and Testing Events, for a summary of results from past Navy monitoring). Continued monitoring efforts over time will be necessary to begin to evaluate the long-term consequences of exposure to noise sources.

3.4.3.1.4 Thresholds and Criteria for Predicting Acoustic and Explosive Impacts on Marine Mammals

If proposed Navy activities introduce sound or explosive energy into the marine environment, an analysis of potential impacts on marine mammals is conducted. To do this, information about the numerical sound and energy levels that are likely to elicit certain types of physiological and behavioral reactions is needed. Thresholds and criteria are not presented for polar bears or walruses. Although they may occur in the Study Area, they are unlikely to occur in areas overlapping with use of explosive or sonar and other active acoustic sources.

3.4.3.1.4.1 Mortality and Injury from Explosives

There is a considerable body of laboratory data on injuries from impulsive sound exposure, usually from explosive pulses, obtained from tests with a variety of lab animals (e.g., mice, rats, dogs, pigs, sheep, and other species). Onset mortality (a severe lung injury with mortality occurring in 1 percent of those having this injury), onset slight lung injury, and onset slight gastrointestinal tract injury represent a series of effects with decreasing likelihood of serious injury or lethality. Primary impulse injuries from explosive blasts are the result of differential compression and rapid re-expansion of adjacent tissues of different acoustic properties (e.g., between gas-filled and fluid-filled tissues or between bone and soft tissues). These injuries usually manifest themselves in the gas-containing organs (lung and gut) and auditory structures (e.g., rupture of the eardrum across the gas-filled spaces of the outer and inner ear) (Craig and Hearn 1998; Craig Jr. 2001).

Criteria and thresholds for predicting mortality and injury to marine mammals from explosions were initially developed for the U.S. Navy shock trials of the USS Seawolf submarine (Craig and Hearn 1998) and USS Winston S. Churchill surface ship (Craig Jr. 2001). Similar criteria and thresholds also were used for the shock trial of the U.S. Navy amphibious transport dock ship USS *Mesa Verde* (U.S. Department of the Navy 2008) and were subsequently adopted by NMFS in their MMPA Final Rule authorizing the USS *Mesa Verde* shock trial (National Marine Fisheries Service 2008c). Functional hearing ranges are not applied for lethal and injurious exposures. These criteria and their origins are explained in greater detail in the Criteria and Thresholds for U.S. Navy Acoustic Effects Analysis Technical Report (Finneran and Jenkins 2012).

Mortality and Slight Lung Injury

In air or submerged, the most commonly reported internal bodily injury was hemorrhaging in the fine structure of the lungs. Biological damage is governed by the impulse of the underwater blast (pressure integrated over time), not peak pressure or energy (Richmond et al. 1973; Yelverton and Richmond 1981; Yelverton et al. 1973; Yelverton et al. 1975). Therefore, impulse was used as a metric upon which internal organ injury could be predicted.

Explosive thresholds for onset mortality and slight lung injury are indexed to 75 and 93 lb. (34 and 42 kg) for mammals, respectively (Richmond et al. 1973). The regression curves based on these experiments were plotted so that a prediction of mortality to larger animals could be determined as a function of impulse and mass (Craig Jr. 2001). After correction for atmospheric and hydrostatic pressures and based on the cube root scaling of body mass, as used in the Goertner injury model (Goertner 1982), the minimum impulse for predicting onset of extensive lung injury for “1 Percent Mortality” (defined as where most survivors had moderate blast injuries and should survive on their own) and slight lung injury for “0 Percent Mortality” (defined as no mortality, slight blast injuries) (Yelverton and Richmond 1981) were derived for each species. The Navy uses the minimum impulse level predictive of extensive lung injury, the exposure level likely to result in one percent mortality of animals in a population (99 percent would be expected to recover from the injury) as the onset of mortality. The scaling of lung volume to depth is conducted for all species, since data are from experiments with terrestrial animals held near the water's surface and marine mammals’ gaseous cavities compress with depth making them less vulnerable to impulse injury. The received impulse necessary for onset mortality or slight lung injury must be delivered over a time period that is the lesser of the positive pressure duration, or 20 percent of the natural period of the assumed-spherical lung adjusted for the size and depth of the animal. Therefore, as depth increases or animal size decreases, the impulse delivery time to experience an effect decreases (Goertner 1982).

Species-specific calf masses are used for determining impulse-based thresholds because they most closely represent effects on individual species. The Criteria and Thresholds for Navy Acoustic Effects Analysis Technical Report (Finneran and Jenkins 2012) provides a nominal conservative body mass for each species based on newborn weights. In some cases, body masses were extrapolated from similar species rather than the listed species. The scaling of lung volume to depth is conducted for all species since data is from experiments with terrestrial animals held near the water's surface. Because the thresholds for onset of mortality and onset of slight lung injury are proportional to the cube root of body mass, the use of all newborn, or calf, weights rather than representative adult weights results in an over-estimate of effects to animals near an explosion. The range to onset mortality for a newborn compared to an adult animal of the same species can range from less than twice to over four times as far from an explosion, depending on the differences in calf versus adult sizes for a given species and the size of the explosion. Considering that injurious high pressures due to explosions propagate away from detonations in a roughly spherical manner, the volumes of water in which the threshold for onset mortality may be exceeded are generally less than a fifth for an adult animal versus a calf.

The use of onset mortality and onset slight lung injury is a conservative method to estimate potential mortality and recoverable (non-mortal, non-PTS) injuries. When analyzing impulse-based effects, all animals within the range to these thresholds are assumed to experience the effect. The onset mortality and onset slight lung injury criteria is based on the impulse at which these effects are predicted for one percent of animals, and then the portion of animals affected would increase closer to the explosion. As discussed above, due to these conservative criteria used to predict these effects, it is likely that fewer animals would be affected than predicted under the Navy's acoustic analysis. Therefore, these criteria conservatively over-estimate the number of animals that could be killed or injured.

Onset of Gastrointestinal Tract Injury

Evidence indicates that gas-containing internal organs, such as lungs and intestines, are the principal damage sites from shock waves in submerged terrestrial mammals (Clark and Ward 1943; Greaves et al. 1943; Richmond et al. 1973; Yelverton et al. 1973). Furthermore, slight injury to the gastrointestinal tract may be related to the peak pressure of the shock wave and would be independent of the animal's size and mass (Goertner 1982).

There are instances where injury to the gastrointestinal tract could occur at a greater distance from the source than slight lung injury, especially near the surface. Gastrointestinal tract injury from small test charges (described as "slight contusions") was observed at peak pressure levels as low as 104 pounds per square inch (psi), equivalent to a sound pressure level of 237 dB re 1 µPa (Richmond et al. 1973). This criterion was previously used by the Navy and NMFS for ship shock trials (FR 73 (143): 43130-43138, July 24, 2008)(National Marine Fisheries Service 2008c; U.S. Department of the Navy 1998, 2001, 2008).

3.4.3.1.4.2 Frequency Weighting

Frequency-weighting functions are used to adjust the received sound level based on sensitivity of the animal to the frequency of the sound. The weighting functions de-emphasize sound exposures at frequencies to which marine mammals are not particularly sensitive. This effectively makes the acoustic thresholds frequency-dependent, which means they are applicable over a wide range of frequencies and therefore applicable for a wide range of sound sources. Frequency-weighting functions, called "M-weighting" functions, were proposed by Southall et al. (2007) to account for the frequency bandwidth of hearing in marine mammals. These M-weighting functions were derived for each marine mammal hearing group based on an algorithm using the range of frequencies that are within 80 dB of an animal or group's best hearing sensitivity at any frequency (Southall et al., 2007). The Southall et al. (2007) M-weighting functions are nearly flat between the lower and upper cutoff frequencies, and thus were believed to represent a conservative approach to assessing the effects of noise (Figure 3.4-4). For the purposes of this analysis, the Navy will refer to these as Type I auditory weighting functions. Phocid seal thresholds and weighting functions

Frequency Weighting Example:

A common dolphin, a mid-frequency cetacean (see Table 3.4-2), receives a 10 kHz ping from a sonar with a sound exposure level (SEL) of 180 dB re 1 µPa^2-s. To discern if this animal may suffer a TTS, the received level must first be adjusted using the appropriate Type II auditory weighting function for mid-frequency cetaceans (Figure 3.4-5). At 10 kHz, the weighting factor for mid-frequency cetaceans is -3 dB, which is then added to the received level (180 dB re 1µPa^2-s + (-3 dB) = 177 dB re 1µPa^2-s) to yield the weighted received level. This is compared to the non-impulsive mid-frequency cetacean TTS threshold (178 dB re 1 µPa^2-s; Table 3.4-3). Since the adjusted received level is less than the threshold, TTS is not likely for this animal from this exposure.

were applied to sirenians (manatees and dugongs) based on the similarities of their hearing ranges and auditory threshold curves (Gerstein et al. 1999).

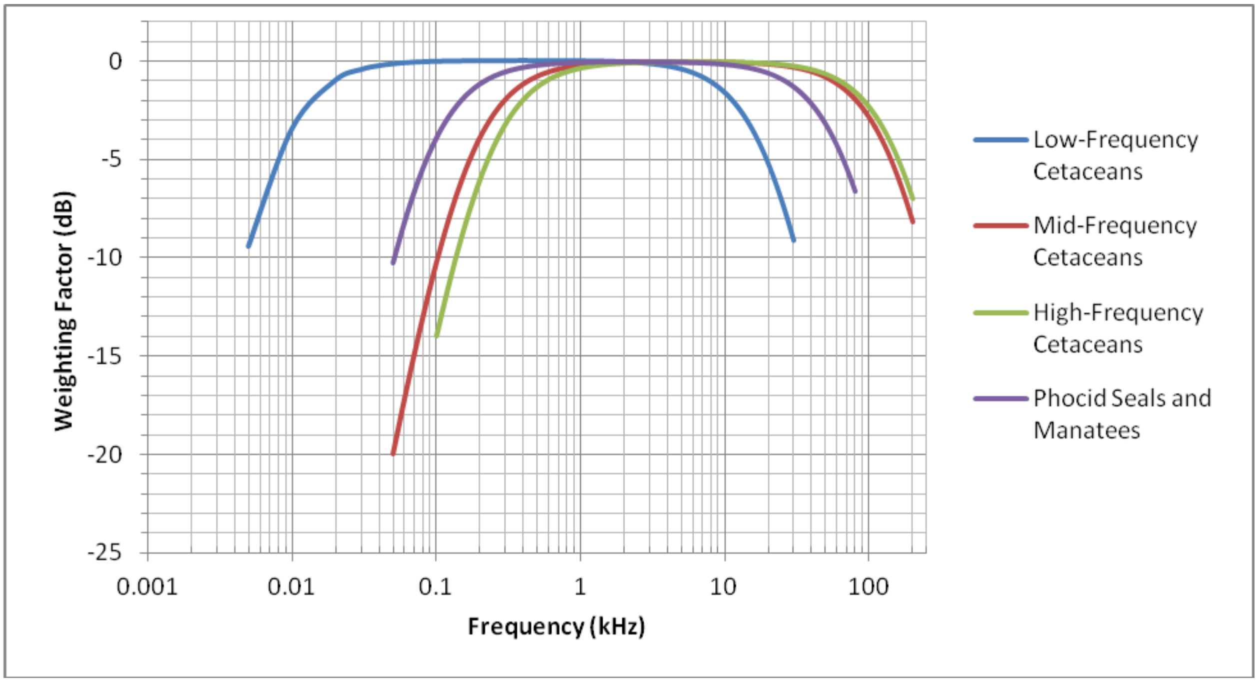


Figure 3.4-4: Type I Auditory Weighting Functions Modified from Southall et al. (2007) M-Weighting Functions

While all data published since 2007 were reviewed to determine if any adjustments to the weighting functions were required, only two published experiments suggested that modification of the mid-frequency cetacean auditory weighting function was necessary (see Finneran and Jenkins (2012) for more details on that modification not otherwise provided below). The first experiment measured TTS in a bottlenose dolphin after exposure to pure tones with frequencies from 3–28 kHz (Finneran 2010). These data were used to derive onset-TTS values as a function of exposure frequency, and demonstrate that the use of a single numeric threshold for onset-TTS, regardless of frequency, is not correct. The second experiment examined how subjects perceived the loudness of sounds at different frequencies to derive equal loudness contours (Finneran and Schlundt 2011). These data are important because human auditory weighting functions are based on equal loudness contours. The dolphin equal loudness contours provide a means to generate auditory weighting functions in a manner directly analogous to the approach used to develop safe exposure guidelines for people working in noisy environments (National Institute for Occupational Safety and Health 1998). Taken together, the recent higher-frequency TTS data and equal loudness contours provide the underlying data necessary to develop new weighting functions, referred to as Type II auditory weighting functions, to improve accuracy and avoid underestimating the impacts on animals at higher frequencies (Figure 3.4-5). To generate the new Type II weighting functions, Finneran and Schlundt (2011) substituted lower- and upper-frequency values which differ from the values used by Southall et al. (2007). The new weighting curve predicts appreciably higher (almost 20 dB) susceptibility for frequencies above 3 kHz for bottlenose dolphins, a mid-frequency cetacean. Since data below 3 kHz are not available, the original weighting functions from Southall et al. (2007) were substituted below this frequency. Low- and high-frequency cetacean weighting functions were extrapolated from the dolphin data as well because of the suspected similarities of greatest susceptibility at best frequencies of hearing. Similar type II weighting curves were not developed for pinnipeds since their hearing is markedly different from cetaceans, and because they do not hear as well at higher frequencies. Their weighting curves do not require the same adjustment (see Finneran and Jenkins 2012 for additional details).

The Type II auditory weighting functions (Figure 3.4-5) are applied to the received sound level before comparing it to the appropriate sound exposure level thresholds for TTS or PTS, or the explosive behavioral response threshold. For some criteria, received levels are not weighted before being compared to the thresholds to predict effects. These include the peak pressure criteria for predicting TTS and PTS from underwater explosions; the acoustic impulse metrics used to predict onset-mortality and slight lung injury from underwater explosions; and the thresholds used to predict behavioral responses from harbor porpoises and beaked whales from sonar and other active acoustic sources.

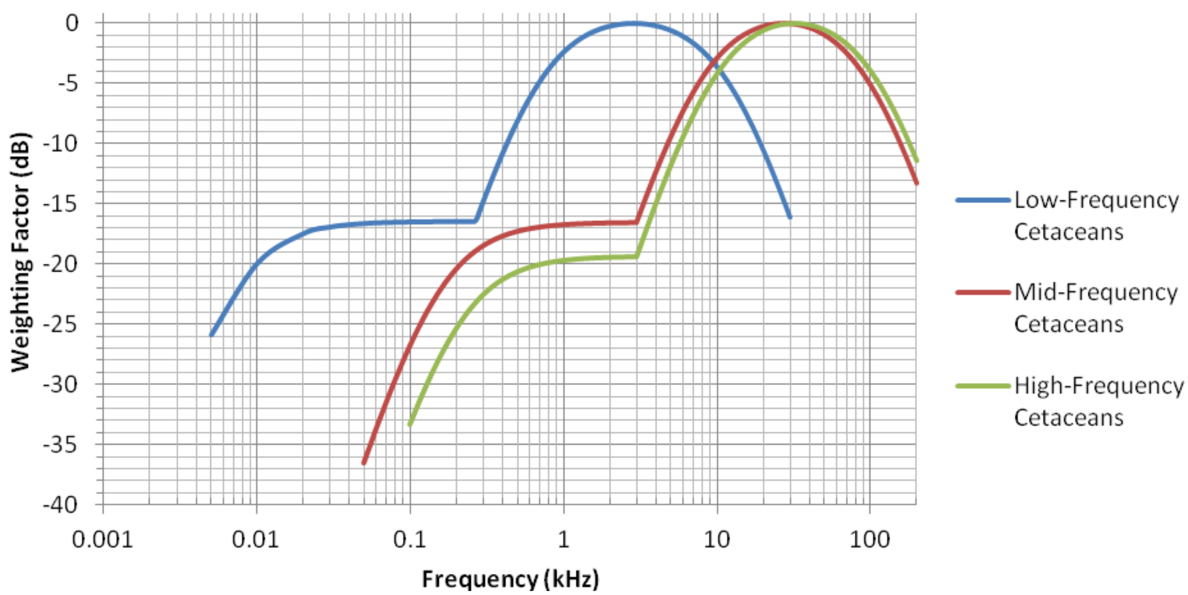


Figure 3.4-5: Type II Weighting Functions for Low-, Mid-, and High-Frequency Cetaceans

3.4.3.1.4.3 Summation of Energy from Multiple Sources

In most cases, an animal's received level will be the result of exposure to a single sound source. In some scenarios, however, multiple sources will be operating simultaneously, or nearly so, creating the potential for accumulation of energy from multiple sources. Energy is summed for multiple exposures of similar source types. For sonars, including use of multiple systems within any scenario, energy will be summed for all exposures within a cumulative exposure band, with the cumulative exposure bands defined in four bands: 0–1.0 kHz (low-frequency sources); 1.1–10.0 kHz (mid-frequency sources); 10.1–100.0 kHz (high-frequency sources); and above 100.0 kHz (very high-frequency sources). Sources operated at frequencies above 200 kHz are considered to be inaudible to all groups of marine mammals and are not analyzed in the quantitative modeling of exposure levels. After the energy has been summed within each frequency band, the band with the greatest amount of energy is used to evaluate the onset of PTS or TTS. For explosives, including use of multiple explosives in a single scenario, energy is summed across the entire frequency band.

3.4.3.1.4.4 Hearing Loss: Temporary and Permanent Threshold Shift

Criteria for physiological effects from sonar and other active acoustic sources are based on TTS and PTS with thresholds based on cumulative sound exposure levels (Table 3.4-4). The onset of TTS or PTS from exposure to underwater explosions is predicted using sound exposure level-based thresholds in conjunction with peak pressure thresholds. The horizontal ranges are then compared, with the threshold producing the longest range being the one used to predict effects. For multiple exposures within any 24-hour period, the received sound exposure level for individual events are accumulated for each marine mammal.

Since no studies have been designed to intentionally induce PTS in marine mammals due to the moral and ethical issues inherent in such a study, onset-PTS levels for these animals must be estimated using empirical TTS data obtained in marine mammals and relationships between TTS and PTS established in terrestrial mammals.

TTS and PTS thresholds are based on TTS onset values for impulsive and non-impulsive sounds obtained from representative species of mid- and high-frequency cetaceans and pinnipeds. These data are then extended to the other marine mammals for which data are not available. The Criteria and Thresholds for Navy Acoustic Effects Analysis Technical Report (Finneran and Jenkins 2012) provides a detailed explanation of the selection of criteria and derivation of thresholds for temporary and permanent hearing loss for marine mammals. Table 3.4-3 and Table 3.4-4 provide a summary of acoustic thresholds for TTS and PTS for marine mammals.

Table 3.4-3: Acoustic Criteria and Thresholds for Predicting Physiological Effects on Marine Mammals from Sonar and Other Active Acoustic Sources

Group	Species	Physiological	
		Onset TTS	Onset PTS
Low-Frequency Cetaceans	All mysticetes	178 dB re 1μPa^2-s SEL (Type II weighting)	198 dB re 1μPa^2-s SEL (Type II weighting)
Mid-Frequency Cetaceans	Dolphins, beaked whales, and medium and large toothed whales	178 dB re 1μPa^2-s SEL (Type II weighting)	198 dB re 1μPa^2-s SEL (Type II weighting)
High-Frequency Cetaceans	Harbor porpoise and *Kogia* spp.	152 dB re 1μPa^2-s SEL (Type II weighting)	172 dB re 1μPa^2-s SEL (Type II weighting)
Phocid Seals (In-Water)	Harbor, bearded, hooded common, spotted, ringed, harp, ribbon, & gray seals	183 dB re 1μPa^2-s SEL (Type I weighting)	197 dB re 1μPa^2-s SEL (Type I weighting)
Manatees	West Indian manatee		

dB re 1μPa^2-s: decibel referenced to 1 micro pascal-squared seconds; PTS: permanent threshold shift; SEL: sound exposure level; SPL: sound pressure level; TTS: temporary threshold shift

Table 3.4-4: Criteria and Thresholds for Predicting Physiological Effects on Marine Mammals from Explosives

Group	Species	Onset TTS	Onset PTS	Onset Slight GI Tract Injury	Onset Slight Lung Injury[1]	Onset Mortality[1]
Low-Frequency Cetaceans	All mysticetes	172 dB re 1 μPa^2-s SEL (Type II weighting) or 224 dB re 1 μPa Peak SPL (unweighted)	187 dB re 1 μPa^2-s SEL (Type II weighting) or 230 dB re 1 μPa Peak SPL (unweighted)	237 dB re 1 μPa (unweighted)	Equation 1	Equation 2
Mid-Frequency Cetaceans	Most dolphins, beaked whales, med and large toothed whales	172 dB re 1 μPa^2-s SEL (Type II weighting) or 224 dB re 1 μPa Peak SPL (unweighted)	187 dB re 1 μPa^2-s SEL (Type II weighting) or 230 dB re 1 μPa Peak SPL (unweighted)			
High-Frequency Cetaceans	Porpoises and *Kogia* spp.	146 dB re 1 μPa^2-s SEL (Type II weighting) or 195 dB re 1 μPa Peak SPL (unweighted)	161 dB re 1 μPa^2-s SEL (Type II weighting) or 201 dB re 1 μPa Peak SPL (unweighted)			
Phocid Seals (In-Water)	Harbor, bearded, hooded common, spotted, ringed, harp, ribbon, and gray seals	177 dB re 1μPa^2-s (Type I weighting) or 212 dB re 1 μPa Peak SPL (unweighted)	192 dB re 1μPa^2-s (Type I weighting) or 218 dB re 1 μPa Peak SPL (unweighted)			
Sirenia	Manatees					

(1) $$= 39.1M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-\sec$$

(2) $$= 91.4M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-\sec$$

dB re 1 μPa: decibel referenced to 1 micro pascal; dB re 1μPa^2-s: decibel referenced to 1 micro pascal-squared seconds; Drm: depth of the receiver (animal) in meters; GI: gastrointestinal injury; M: mass of the animals in kg; PTS: permanent threshold shift; SEL: sound exposure level; SPL: sound pressure level; TTS: temporary threshold shift

[1] Impulse calculated over a delivery time that is the lesser of the initial positive pressure duration or 20 percent of the natural period of the assumed-spherical lung adjusted for animal size and depth.

<u>**Temporary Threshold Shift for Sonar and Other Active Acoustic Sources**</u>

TTS values for mid-frequency cetaceans exposed to non-impulsive sound are derived from multiple studies (Finneran et al. 2010a; Finneran et al. 2005a; Mooney et al. 2009a; Schlundt et al. 2000) from two species, bottlenose dolphins and beluga whales. Especially notable are data for frequencies above 3 kHz, where bottlenose dolphins exhibited lower TTS onset thresholds than at 3 kHz (Finneran and Schlundt 2010). This difference in TTS onset at higher frequencies is incorporated into the weighting functions (Section 3.4.3.1.4.2 above Frequency Weighting).

Lucke et al. (2009) measured TTS in a harbor porpoise exposed to a small seismic air gun and those results are reflected in the impulse sound TTS thresholds described below. The beluga whale (the only species for which both impulsive and non-impulsive TTS data exist) has a (weighted) non-impulsive TTS onset value 6 dB above the (weighted) impulsive threshold (Finneran et al. 2002; Schlundt et al. 2000). Therefore, 6 dB was added to the harbor porpoise's impulsive TTS threshold demonstrated by Lucke et al. (2009) to derive the non-impulse TTS threshold used in the current Navy modeling for high-frequency cetaceans. This value was similar to what Kastelein et al. (2012b) found for harbor porpoises exposed to higher sound levels or longer durations of exposure time, when they used octave band noise centered at 4 kHz to extrapolate an onset TTS threshold for three different received levels and six durations.The Kastelein et al. (2012b) study was the first direct measurement of TTS from non-impulsive sound for harbor porpoises.

There are no direct measurements of TTS or hearing abilities for low-frequency cetaceans. The Navy uses mid-frequency cetacean thresholds to assess PTS and TTS for low-frequency cetaceans, since mid-frequency cetaceans are the most similar to the low-frequency cetacean group.

Pinniped TTS criteria are based on data provided by Kastak et al. (2005) for representative species of both of the pinniped hearing groups: harbor seals (Phocidae) and California sea lions (Otariidae and Odobenidae). Kastak et al. (2005) used octave band noise centered at 2.5 kHz to extrapolate an onset TTS threshold. More recently Kastelein et al. (2012a) used octave band noise centered at 4 kHz to obtain TTS thresholds in the same two species resulting in similar levels causing onset-TTS as those found in Kastak et al. (2005). Based on similarities of manatee hearing ranges (Gerstein et al. 1999) to phocid seal hearing ranges, the phocid TTS threshold is applied to manatees.

The appropriate frequency weighting function for each species group is applied when using the sound exposure level-based thresholds to predict TTS.

Temporary Threshold Shift for Explosives

The TTS sound exposure level thresholds for cetaceans are consistent with the thresholds approved by NMFS for the USS *Mesa Verde* ship shock trial (FR 73 (143): 43130-43138, July 24, 2008) and are more representative of TTS induced from impulses (Finneran et al. 2002) rather than pure tones (Schlundt et al. 2000). In most cases, a total weighted sound exposure level is more conservative than the greatest sound exposure level in any single 1/3-octave band, which was used prior to the USS *Mesa Verde* shock trial. There are no data on TTS obtained directly from low-frequency cetaceans, so mid-frequency cetacean impulse threshold criteria from Finneran et al. (2002) have been used. High-frequency cetacean TTS thresholds are based on research by Lucke et al. (2009), who exposed harbor porpoises to pulses from a single air gun.

Pinniped thresholds were not included for prior ship shock trials, as pinnipeds were not expected to occur at the shock trial sites due to their distance from shore, and TTS thresholds for previous Navy Environmental Impact Statements (EISs)/Overseas Environmental Impact Statements (OEISs) also were not differentiated between cetaceans and pinnipeds (FR 73 (143): 43130-43138, July 24, 2008). TTS values for impulse sound have not been obtained for pinnipeds, but there are TTS data for octave band sound from representative species of both major pinniped hearing groups (Kastak et al. 2005). Impulse sound TTS criteria for pinnipeds were estimated by applying the difference between mid-frequency cetacean TTS onset for impulse and non-impulse sounds to the pinniped non-impulse TTS data (Kastak et al. 2005), a methodology originally developed by Southall et al. (2007). Therefore, the TTS threshold for sounds from explosions for pinnipeds is 6 dB less than the non-impulsive onset-TTS threshold derived from Kastak et al. (2005). Based on similarities of manatee hearing ranges (Gerstein et al. 1999) to phocid seal hearing ranges, the phocid TTS threshold for explosions is applied to manatees as well.

The appropriate frequency weighting function for each species group is applied when using the sound exposure level-based thresholds to predict TTS.

Permanent Threshold Shift for Sonar and Other Active Acoustic Sources

There are no direct measurements of PTS onset in marine mammals. Well-understood relationships between terrestrial mammalian TTS and PTS have been applied to marine mammals. Threshold shifts up to 40–50 dB have been induced in terrestrial mammals without resultant PTS (Miller et al. 1963; Ward et al. 1958; Ward et al. 1959b). These data would suggest that 40 dB of TTS would be a reasonable limit for approximating the beginning of PTS for marine mammals exposed to continuous sound. Data from terrestrial mammal testing (Ward et al. 1958; Ward et al. 1959b) show growth of TTS by 1.5 to 1.6 dB for every 1 dB increase in exposure level. The difference between measurable TTS onset (6 dB) and the selected 40 dB upper safe limit of TTS yields a difference in TTS of 34 dB which, when divided by a TTS growth function of 1.6 indicates that an increase in exposure of 21 dB would result in 40 dB of TTS. For simplicity and additional conservatism, the number was rounded down to 20 dB (Southall et al. 2007).

Therefore, exposures to sonar and other active acoustic sources with levels 20 dB above those producing TTS are assumed to produce PTS. For example, an onset-TTS threshold of 195 dB re 1 μPa^2-s would have a corresponding onset-PTS threshold of 215 dB re 1 μPa^2-s. This extrapolation process is identical to that recently proposed by Southall et al. (2007). The method predicts greater effects than have actually been observed in tests on a bottlenose dolphin (Schlundt et al. 2006) and is therefore protective.

Kastak et al. (2007) obtained different TTS growth rates for pinnipeds than Finneran and colleagues obtained for mid-frequency cetaceans. NMFS recommended reducing the estimated PTS criteria for both groups of pinnipeds, based on the difference in TTS growth rate reported by Kastak et al. (2007) (14 dB instead of 20 dB).

The appropriate frequency weighting function for each species group is applied when using the sound exposure level-based thresholds to predict PTS.

Permanent Threshold Shift for Explosives

Since marine mammal PTS data from impulsive exposures do not exist, onset-PTS levels for these animals are estimated by adding 15 dB to the sound exposure level-based TTS threshold and by adding 6 dB to the peak pressure-based thresholds. These relationships were derived by Southall et al. (2007) from impulse noise TTS growth rates in chinchillas. The appropriate frequency weighting function for each species group is applied when using the sound exposure level-based thresholds to predict PTS.

3.4.3.1.4.5 Behavioral Responses

Behavioral response criteria are used to estimate the number of animals that may exhibit a behavioral response. In this analysis, animals may be behaviorally harassed in each modeled scenario (using the Navy Acoustic Effects Model) or within each 24-hour period, whichever is shorter. Therefore, the same animal could have a behavioral reaction multiple times over the course of a year.

Sonar and Other Active Acoustic Sources

Potential behavioral effects from in-water sound from sonar and other active acoustic sources were predicted using the behavioral response functions for most marine mammal species. The received sound level is weighted with the Type I auditory weighting functions (Figure 3.4-4) before the behavioral response function is applied. The harbor porpoise and beaked whales are the exception. They have unique criteria based on specific data that show these animals to be especially sensitive to sound. Harbor porpoise and beaked whale non-impulsive behavioral criteria are used unweighted – without weighting the received level before comparing it to the threshold.

Behavioral Response Functions

The Navy worked with NMFS to define a mathematical function used to predict potential behavioral effects to mysticetes (Figure 3.4-7) and odontocetes (Figure 3.4-8) from mid-frequency sonar (National Marine Fisheries Service 2008a). This analysis assumes that the probability of eliciting a behavioral response to sonar and other active acoustic sources on individual animals would be a function of the received sound pressure level (dB re 1 µPa). The behavioral response function applied to mysticetes (Figure 3.4-7) differs from that used for odontocetes and pinnipeds (Figure 3.4-6) in having a shallower slope, which results in the inclusion of more behavioral impacts at lower received levels, consistent with observational data from North Atlantic right whales (Nowacek et al. 2007). Although the response functions differ, the intercepts on each figure highlight that each function has a 50 percent probability of harassment at a received level of 165 dB sound pressure level. These analyses assume that sound poses a negligible risk to marine mammals if they are exposed to sound pressure levels below a certain basement value.

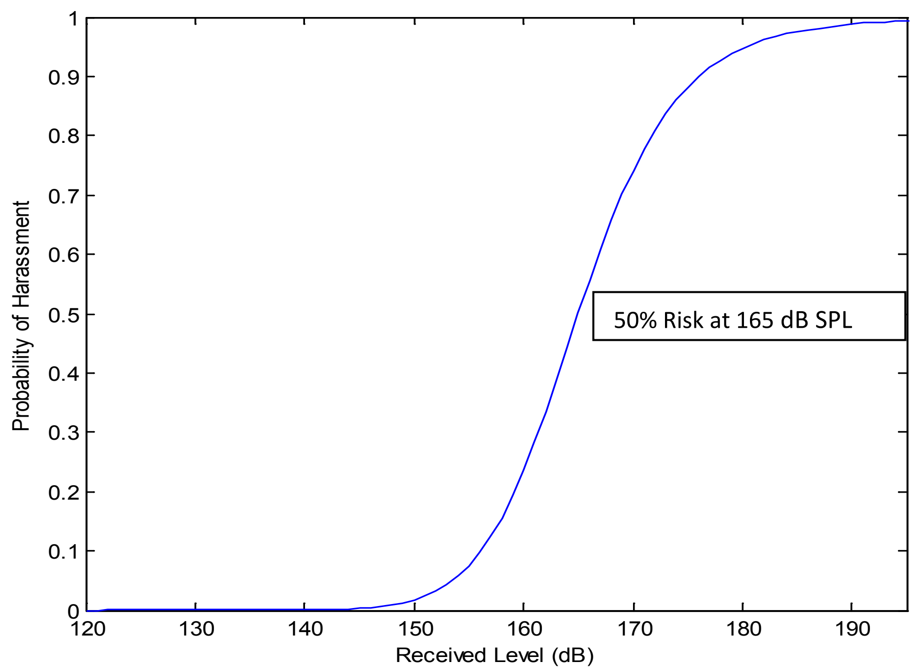


Figure 3.4-6: Behavioral Response Function Applied to Odontocetes and Pinnipeds (BRF_2) (excluding Beaked Whales and Harbor Porpoises)

dB: decibel; SPL: sound pressure level; %: percent

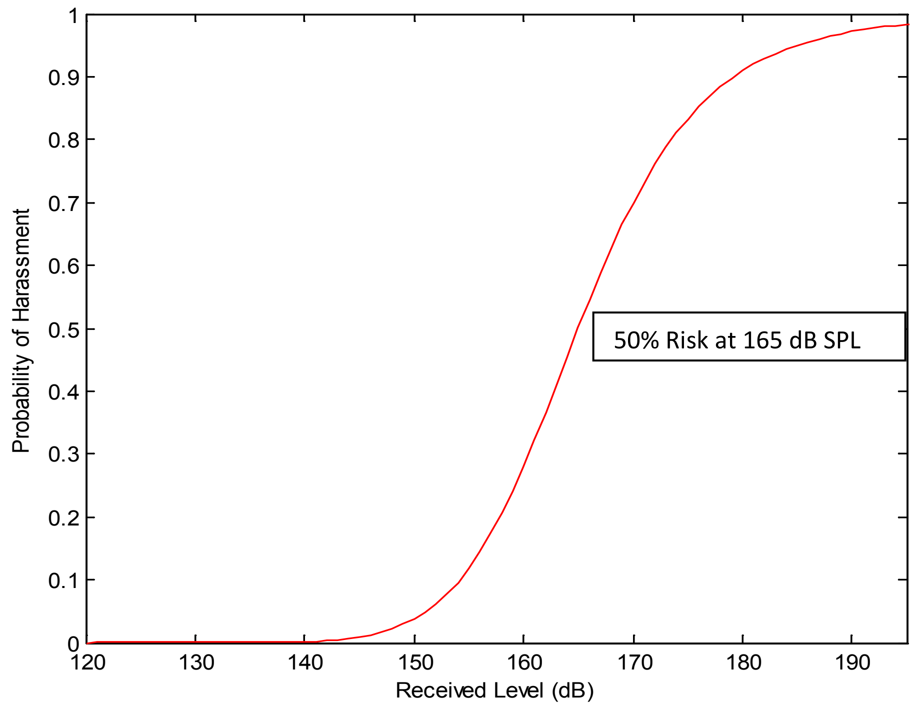


Figure 3.4-7: Behavioral Response Function Applied to Mysticetes (BRF$_1$)
dB: decibel; SPL: sound pressure level; %: percent

The values used in this analysis are based on three sources of data: behavioral observations during TTS experiments conducted at the Navy Marine Mammal Program (Finneran et al. 2001, 2003b; Finneran et al. 2005a; Finneran and Schlundt 2004); reconstruction of sound fields produced by the USS *Shoup* associated with the behavioral responses of killer whales observed in Haro Strait (Fromm 2009; National Marine Fisheries Service Office of Protected Resources 2005; U.S. Department of the Navy 2003); and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components documented in Nowacek et al. (2004a).

In some circumstances, some individuals will continue normal behavioral activities in the presence of high levels of human-made noise. In other circumstances, the same individual or other individuals may avoid an acoustic source at much lower received levels (Richardson et al. 1995; Southall et al. 2007; Wartzok et al. 2003). These differences within and between individuals appear to result from a complex interaction of experience, motivation, and learning that are difficult to quantify and predict. Therefore, the behavioral response functions represent a relationship that is deemed generally accurate, but may not be true in specific circumstances.

Specifically, the behavioral response function treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, many other variables such as the marine mammal's gender, age, and prior experience; the activity it is engaged in during a sound exposure; its distance from a sound source; the number of sound sources; and whether the sound sources are approaching or moving away from the animal can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall et al. 2007). At present, available data do not allow for incorporation of these other variables in the current behavioral response functions;

however, the response function represents the best use of the data that are available. Furthermore, the behavioral response functions do not differentiate between different types of behavioral reactions (e.g., area avoidance, diving avoidance, or alteration of natural behavior) or provide information regarding the predicted consequences of the reaction.

The behavioral response function is used to estimate the percentage of an exposed population that is likely to exhibit behaviors that would qualify as harassment (as that term is defined by the MMPA applicable to military readiness activities, such as the Navy's testing and training with mid-frequency active sonar) at a given received level of sound. For example, at 165 dB sound pressure level (dB re 1 µPa root mean square), the risk (or probability) of harassment is defined according to this function as 50 percent. This means that 50 percent of the individuals exposed at that received level would be predicted to exhibit a significant behavioral response.

Harbor Porpoises

The information currently available regarding this species suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (Kastelein et al. 2000; Kastelein et al. 2005c) and wild harbor porpoises (Johnston 2002) responded to sound (e.g., acoustic harassment devices, acoustic deterrent devices, or other non-impulsive sound sources) are very low, approximately 120 dB re 1 µPa. Therefore, a sound pressure level of 120 dB re 1 µPa is used in this analysis as a threshold for predicting behavioral responses in harbor porpoises (Table 3.4-5).

Table 3.4-5: Summary of Behavioral Thresholds for Marine Mammals

Group	Behavioral Thresholds for Sonar and Other Active Acoustic Sources	Behavioral Thresholds for Explosions
Low-Frequency Cetaceans	SPL: BRF_1 (Type I weighting)	167 dB re 1 µPa^2-s SEL (Type II Weighting)
Mid-Frequency Cetaceans	SPL: BRF_2 (Type I weighting)	167 dB re 1 µPa^2-s SEL (Type II Weighting)
High-Frequency Cetaceans	SPL: BRF_2 (Type I weighting)	141 dB re 1 µPa^2-s SEL (Type II Weighting)
Phocid Seals (In-Water)	SPL: BRF_2 (Type I weighting)	172 dB re 1 µPa^2-s SEL (Type I Weighting)
Manatees	SPL: BRF_2 (Type I weighting)	172 dB re 1 µPa^2-s SEL (Type I Weighting)
Beaked Whales	(unweighted) SPL: 140 dB re 1µPa	167 dB re 1 µPa^2-s SEL (Type II Weighting)
Harbor Porpoises	(unweighted) SPL: 120 dB re 1µPa	141 dB re 1 µPa^2-s SEL (Type II Weighting)

BRF: Behavioral Response Function; dB re 1 µPa: decibel referenced to 1 micro pascal; dB re 1µPa^2-s: decibel referenced to 1 micro pascal-squared seconds; SEL: Sound Exposure Level; SPL: Sound Pressure Level

Beaked Whales

The inclusion of a special behavioral response criterion for beaked whales of the family Ziphiidae is new to these Phase II criteria. It has been speculated for some time that beaked whales might have unusual sensitivities to sound due to a few strandings in conjunction with mid-frequency sonar use, even in areas where other species were more abundant (D'Amico et al. 2009), but there were not sufficient data to support a separate treatment for beaked whales until recently. With the recent publication of results from Blainville's beaked whale monitoring and experimental exposure studies on the instrumented

Atlantic Undersea Test and Evaluation Center range in the Bahamas (McCarthy et al. 2011; Tyack et al. 2011), there are now statistically strong data suggesting that beaked whales tend to avoid both actual naval mid-frequency sonar in real anti-submarine training scenarios as well as sonar-like signals and other signals used during controlled sound exposure studies in the same area. Tyack et al. (2011) report that, in reaction to sonar playbacks, most beaked whales stopped echolocation, made a long slow ascent, and moved away from the sound. During an exercise using mid-frequency sonar, beaked whales avoided the area at a distance from the sonar where the received level was "around 140 dB" (sound pressure level) and once the exercise ended, beaked whales re-inhabited the center of the exercise area within two to three days (Tyack et al. 2011). The Navy therefore adopted a 140 dB re 1 µPa sound pressure level threshold for significant behavioral effects for all beaked whales (family: Ziphiidae) (Table 3.4-5).

Since the development of the criterion, analysis of the data the 2010 and 2011 field seasons of the southern California Behavioral Responses Study has been published. The study, DeRuiter et al. (2013), provides similar evidence of Cuvier's beaked whale sensitivities to sound based on two controlled exposures. Two whales, one in each season, were tagged and exposed to simulated mid-frequency active sonar at distances of 3.4 – 9.5 km. The 2011 whale was also incidentally exposed to mid-frequency active sonar from a distant naval exercise (approximately 118 km away). Received levels from the mid-frequency active sonar signals during the controlled and incidental exposures were calculated as 84-144 and 78-106 dB re 1 µPa root mean squared, respectively. Both whales showed responses to the controlled exposures, ranging from initial orientation changes to avoidance responses characterized by energetic fluking and swimming away from the source. However, the authors did not detect similar responses to incidental exposure to distant naval sonar exercises at comparable received levels, indicating that context of the exposures (e.g., source proximity, controlled source ramp-up) may have been a significant factor. Because the sample size was limited (controlled exposures during a single dive in both 2010 and 2011), baseline behavioral data was obtained from different stocks and geographic areas (i.e., Hawaii and Mediterranean Sea), and the responses exhibited to controlled exposures were not exhibited by an animal exposed to some of the same received levels of real sonar exercises. The Navy relied on the studies at the Atlantic Undersea Test and Evaluation Center that analyzed beaked whale responses to actual naval exercises using mid-frequency active sonar to inform the acoustic criterion to predict potential behavioral responses by beaked whales to proposed training and testing activities using sonar and other active acoustic sources.

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 events with multiple explosions, the behavioral threshold used in this analysis is 5 dB less than the TTS onset threshold (in sound exposure level) (Table 3.4-5). This value is derived from observed onsets of behavioral response by test subjects (bottlenose dolphins) during non-impulse TTS testing (Schlundt et al. 2000).

Some multiple explosion events, 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 FR 230; 66 FR 87; 73 FR 143) and is extended to the criteria used in this analysis.

Since impulse events can be quite short, it may be possible to accumulate multiple received impulses at sound pressure levels considerably above the energy-based criterion and still not be considered a behavioral take. The Navy treats all individual received impulses as if they were one second long for the purposes of calculating cumulative sound exposure level for multiple impulse events. For example, five air gun impulses, each 0.1 second long, received at 178 dB sound pressure level would equal a 175 dB sound exposure level, and would not be predicted as leading to a significant behavioral response. However, if the five 0.1 second pulses are treated as a five-second exposure, it would yield an adjusted value of approximately 180 dB, exceeding the threshold. For impulses associated with explosions that have durations of a few microseconds, this assumption greatly overestimates effects based on sound exposure level metrics such as TTS, PTS, and behavioral responses.

Appropriate weighting values will be applied to the received impulse in one-third octave bands and the energy summed to produce a total weighted sound exposure level value. For impulsive behavioral criteria, the new weighting functions (Figure 3.4-5) are applied to the received sound level before being compared to the threshold.

Pile Driving and Airgun Criteria and Thresholds

Existing NMFS risk criteria are applied to the unique sounds generated by impact pile driving, vibratory pile installation and removal, and airguns (Table 3.4-6).

Table 3.4-6: Pile Driving and Airgun Thresholds Used in this Analysis to Predict Effects on Marine Mammals

Species Groups	Underwater Vibratory Pile Driving Criteria (Sound Pressure Level, dB re 1 µPa)		Underwater Impact Pile Driving and Airgun Criteria (Sound Pressure Level, dB re 1 µPa)	
	Level A Injury Threshold	Level B Disturbance Threshold	Level A Injury Threshold	Level B Disturbance Threshold
Cetaceans (Whales, Dolphins, Porpoises)	180 dB rms	120 dB rms	180 dB rms	160 dB rms
Pinnipeds (Seals)	190 dB rms	120 dB rms	190 dB rms	160 dB rms

dB: decibel; dB re 1 µPa: decibel referenced to 1 micro pascal; rms: root mean square

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.

3.4.3.1.5 Quantitative Analysis

The Navy performed a quantitative analysis to estimate the number of marine mammals that could be affected by acoustic sources or explosives used during Navy training and testing activities. Inputs to the quantitative analysis included marine mammal density estimates; marine mammal depth occurrence distributions; oceanographic and environmental data; marine mammal hearing data; and criteria and thresholds for levels of potential effects. The quantitative analysis consists of computer modeled estimates and a post-model analysis to determine the number of potential mortalities and harassments. The model calculates sound energy propagation from sonars, other active acoustic sources, and explosives during naval activities; the sound or impulse received by animat dosimeters representing marine mammals distributed in the area around the modeled activity; and whether the sound or impulse received by a marine mammal exceeds the thresholds for effects. The model estimates are then further analyzed to consider animal avoidance and implementation of mitigation measures, resulting in final estimates of potential effects due to Navy training and testing.

Various computer models and mathematical equations can be used to predict how energy spreads from a sound source (e.g. sonar or underwater detonation) to a receiver (e.g. dolphin or sea turtle). See the Acoustic and Explosives Primer (Section 3.0.4) for background information about how sound travels through the water. Basic underwater sound models calculate the overlap of energy and marine life using assumptions that account for the many, variable, and often unknown factors that can influence the result. Assumptions in previous and current Navy models have intentionally erred on the side of overestimation when there are unknowns or when the addition of other variables was not likely to substantively change the final analysis. For example, because the ocean environment is extremely dynamic and information is often limited to a synthesis of data gathered over wide areas and requiring many years of research, known information tends to be an average of a seasonal or annual variation. El Niño Southern Oscillation events of the ocean-atmosphere system are an example of dynamic change where unusually warm or cold ocean temperatures are likely to redistribute marine life and alter the propagation of underwater sound energy. Previous Navy modeling therefore made some assumptions indicative of a maximum theoretical propagation for sound energy (such as a perfectly reflective ocean surface and a flat seafloor).

More complex computer models build upon basic modeling by factoring in additional variables in an effort to be more accurate by accounting for such things as bathymetry and an animal's likely presence at various depths.

- The Navy Acoustics Effects Model accounts for the variability of the sound propagation data in both distance and depth when computing the received sound level on the animals. Previous models captured the variability in sound propagation over a range and used a conservative approach to account for only the maximum received sound level within the water column.
- Navy Acoustics Effects Model bases the distribution of animats (virtual representation of an animal) over the operational area on density maps, which provide a more natural distribution of animals. Previous models assumed a uniform distribution of animals over the operational area.
- Navy Acoustics Effects Model distributes animats throughout the three dimensional water space proportional to the known time that animals of that species spend at varying depths. Previous models assumed animals were placed at the depth where the maximum sound received level occurred for each distance from a source.
- Navy Acoustics Effects Model conducts a statistical analysis to compute the estimated effects on animals. Previous models assumed all animals within a defined distance would be affected by the sound.

The Navy has developed a set of data and new software tools for quantification of estimated marine mammal impacts from Navy activities. This new approach is the resulting evolution of the basic model previously used by Navy and reflects a more complex modeling approach as described below. Although this more complex computer modeling approach accounts for various environmental factors affecting acoustic propagation, the current software tools do not consider the likelihood that a marine mammal would attempt to avoid repeated exposures to a sound or avoid an area of intense activity where a training or testing event may be focused. Additionally, the software tools do not consider the implementation of mitigation (e.g., stopping sonar transmissions when a marine mammal is within a certain distance of a ship or mitigation zone clearance prior to detonations). In both of these situations, naval activities are modeled as though an activity would occur regardless of proximity to marine mammals and without any horizontal movement by the animal away from the sound source or human activities. Therefore, the final step of the quantitative analysis of acoustic effects is to consider the implementation of mitigation and the possibility that marine mammals would avoid continued or repeated sound exposures.

The quantified results of the marine mammal acoustic effect analysis presented in this section and in the Requests for Letters of Authorization under the MMPA differ from the quantified results presented in the AFTT Draft EIS/OEIS. Presentation of the results in this new manner for MMPA, ESA, and other regulatory analyses is well within the framework of the previous NEPA analyses presented in the AFTT Draft EIS/OEIS. These differences are due to three factors: (1) refinement of training and testing model inputs; (2) additional post-model analysis of acoustic effects to include animal avoidance of repeated sound exposures, avoidance of areas of activity by sensitive species before use of a sound source or explosive, and implementation of mitigation; and (3) changes to the tempo or location of certain proposed activities. This additional post-model analysis of acoustic effects was performed to clarify potential misunderstanding of the numbers presented as modeling results in the AFTT Draft EIS/OEIS. Some comments indicated that the readers believed the acoustic effects to marine mammals presented in the AFTT Draft EIS/OEIS were representative of the actual expected effects, although the AFTT Draft EIS/OEIS did not account for animal avoidance of an area prior to commencing sound-producing activities, animal avoidance of repeated explosive noise exposures, and the protections due to standard Navy mitigations. Therefore, the numbers presented in this section have been refined to better quantify the expected effects by fully accounting for animal avoidance and implementation of standard Navy mitigations.

The revised model estimates (without consideration of avoidance or mitigation) are presented in a revised technical report (Marine Species Modeling Team 2013).

The sections below describe the steps of the quantitative analysis of acoustic effects.

3.4.3.1.5.1 Marine Mammal Density

A quantitative analysis of impacts on a species requires data on the abundance and distribution of the species population in the potentially impacted area. The most appropriate metric for this type of analysis is density, which is the number of animals present per unit area.

There is no single source of density data for every area of the world, species, and season because of the fiscal costs, resources, and effort involved in providing survey coverage to sufficiently estimate density. Therefore, to characterize the marine species density for large areas such as the Study Area, the Navy compiled data from several sources. To compile and structure the most appropriate database of marine species density data, the Navy developed a protocol to select the best available data sources based on species, area, and time (season). The resulting Geographic Information System database called the Navy Marine Species Density Database includes seasonal density values for every marine mammal and sea turtle species present within the Study Area (U.S. Department of the Navy 2012a).

The Navy Marine Species Density Database includes a compilation of the best available density data from several primary sources and published works including survey data from NMFS within the U.S. Exclusive Economic Zone. In this analysis, marine mammal density data were used as an input in the Navy Acoustic Effects Model in their original temporal (seasonal) and spatial resolution. Seasons are defined as winter (December–February), spring (March–May), summer (June–August), and fall (September– November). The density grid cell spatial resolution varied, depending on the original data source used, from 10 km^2 to 0.5 $degrees^2$ (latitude/longitude). Where data sources overlap, there might be a sudden increase or decrease in density due to different derivation methods or survey data utilized.

This is an artifact of attempting to use the best available data for each geographic region. The density data were used as-is in order to preserve the original values. Any attempt to smooth the data sets would either increase or decrease adjacent values and would inflate the error of those values by an unknown amount.

The Navy modeled acoustic impacts within representative locations where training and testing has historically occurred in the past and is expected to occur in the future. Within the Study Area, the expected geographic extent of some species did not overlap with any area where potential acoustic impacts were modeled. Therefore, since there were no expected impacts from the modeled sources, the following species were excluded from quantitative analysis:

- Bowhead whale
- Beluga whale
- Narwhal
- Walrus
- Polar bear

These species are included for further qualitative assessment of impacts from other nonmodeled sources such as vessel noise, aircraft overflight noise, weapons firing, launch and non-explosive impact noise.

All species density distributions matched the expected distributions from published literature and the NMFS stock assessments, with the exception of long-beaked common dolphin and harbor porpoise. The NMFS stock assessment does not consider long-beaked common dolphin to occur within the U.S. Atlantic Exclusive Economic Zone. However, the Navy Marine Species Density Database predicts a possible low occurrence within the Study Area, extending into the U.S. Exclusive Economic Zone. Since long-beaked common dolphin is a rare or uncommon species in the western Atlantic and the Study Area extends beyond the NMFS survey coverage area, the Navy decided to include this species in the acoustic analysis for completeness since there may be a possible low probability of occurrence within the Study Area.

The harbor porpoise density distribution comprised multiple data sources. The Sea Mammal Research Unit Limited density data source did not match the expected distribution within the NMFS stock assessment survey coverage area. This was a function of the parameters defined for the harbor porpoise habitat model used in the density estimate. The parameters were defined to encompass several distinct harbor porpoise populations across the northern Atlantic and adjacent waters and may not accurately represent the population occurring within the Study Area. Therefore, using the best available definition of the harbor porpoise distribution extent, the Navy corrected and defined the extent to match the distribution published in the NMFS Stock Assessment Report. See U.S. Department of the Navy (2012a) for further details on this correction.

3.4.3.1.5.2 Upper and Lower Frequency Limits

The Navy has adopted a single frequency cutoff at each end of a functional hearing group's frequency range based on the most liberal interpretations of their composite hearing abilities. These are not the same as the values used to calculate weighting curves but exceed the demonstrated or anatomy-based hypothetical upper and lower limits of hearing within each group. Table 3.4-7 provides the lower and upper frequency limits for each species group. Sounds with frequencies below the lower frequency limit, or above the upper frequency limit, are not analyzed with respect to auditory effects for a particular group.

Table 3.4-7: Lower and Upper Cutoff Frequencies for Marine Mammal Functional Hearing Groups Used in this Acoustic Analysis

Functional Hearing Group	Limit (Hz)	
	Lower	Upper
Low-Frequency Cetaceans	5	30,000
Mid-Frequency Cetaceans	50	200,000
High-Frequency Cetaceans	100	200,000
Phocid Seals (In-Water) and Sirenians	50	80,000

Hz: hertz

3.4.3.1.5.3 Navy Acoustic Effects Model

The Navy developed a set of software tools and compiled data for estimating acoustic impacts on marine mammals (without consideration of mitigation or avoidance behavior). These databases and tools collectively form the Navy Acoustic Effects Model. Details of this model's processes and the description and derivation of the inputs are presented in a technical report titled *Determination of Acoustic Effects on Marine Mammals and Sea Turtles* for the AFTT EIS/OEIS (Marine Species Modeling Team 2013).

The Navy Acoustic Effects Model improves upon previous modeling efforts in several ways. First, unlike earlier methods that modeled sources individually, the Navy Acoustic Effects Model has the capability to run all sources within a scenario simultaneously, providing a more realistic depiction of the potential effects of an activity. Second, previous models calculated sound received levels within set volumes of water and spread animals uniformly across the volumes; in the Navy Acoustic Effects Model, animats (virtual animals) are distributed nonuniformly based on higher resolution species-specific density, depth distribution, and group size information, and animats serve as dosimeters, recording energy received at their location in the water column. Third, a fully three-dimensional environment is used for calculating sound propagation and animat exposure in the Navy Acoustic Effects Model, rather than a two-dimensional environment where the worst case sound pressure level across the water column is always encountered. Finally, current efforts incorporate site-specific bathymetry, sound speed profiles, wind speed, and bottom properties into the propagation modeling process rather than the flat-bottomed provinces used during earlier modeling (Marine Species Modeling Team 2013). The following paragraphs provide an overview of the Navy Acoustic Effects Model process and its more critical data inputs.

Using the best available information on the predicted density of marine mammals in the area being modeled, the Navy Acoustic Effects Model derives an abundance (total number of individuals) and distributes the resulting number of animats into an area bounded by the maximum distance that energy propagates out to a criterion threshold value (energy footprint). For example, for non-impulsive sources, all animats that are predicted to occur within a range that could receive sound pressure levels greater than or equal to 120 dB re 1 µPa are distributed. These animats are distributed based on density differences across the area, the group (pod) size, and known depth distributions (dive profiles) . Animats change depths every four minutes but do not otherwise mimic actual animal behaviors, such as avoidance or attraction to a stimulus (horizontal movement), or foraging, social, or traveling behaviors.

Schecklman et al. (2011) argue that static distributions underestimate acoustic exposure compared to a model with fully three-dimensionally moving animals. However, their static method is different from the Navy Acoustic Effects Model in several ways. First, they distribute the entire population at depth with respect to the species-typical depth distribution histogram, and those animats remain static at that position throughout the entire simulation. In the Navy Acoustic Effects Model, animats are placed horizontally dependent on nonuniform density information, and then move up and down over time within the water column by integrating species-typical depth distribution information. Second, for the static method, they calculate acoustic received level for designated volumes of the ocean and then sum the animats that occur within that volume, rather than using the animats themselves as dosimeters, as in the Navy Acoustic Effects Model. Third, Schecklman et al. (2011) ran 50 iterations of the moving distribution to arrive at an average number of exposures, but because they rely on uniform horizontal density (and static depth density), only a single iteration of the static distribution is realized. In addition to moving the animats vertically, the Navy Acoustic Effects Model overpopulates the animats over a nonuniform density and then resamples the population a number of times to arrive at an average number of exposures as well. Tests comparing fully moving distributions and static distributions with vertical position changes at varying rates were compared during development of the Navy Acoustic Effects Model. For position updates occurring more frequently than every five minutes, the number of estimated exposures were similar between the Navy Acoustic Effects Model and the fully moving distribution; however, computational time was much longer for the fully moving distribution.

The Navy Acoustic Effects Model calculates the likely propagation for various levels of energy (sound or pressure) resulting from each non-impulse or impulse source used during a training or testing event. This is done by taking into account the actual bathymetric relief and bottom types (e.g., reflective), and estimated sound speeds and sea surface roughness at an event's location. Platforms (such as a ship using one or more sound sources) are modeled as moving across an area whose size is representative of what would normally occur during a training or testing scenario. The model uses typical platform speeds and event durations. Moving source platforms either travel along a predefined track or move along straight-line tracks from a random initial course, reflecting at the edges of a predefined boundary. Static sound sources are stationary in a fixed location for the duration of a scenario. Modeling locations were chosen based on historical data where activities have been ongoing and in an effort to include as much environmental variation within the Study Area as is reasonably available and can be incorporated into the model.

The Navy Acoustic Effects Model then records the energy received by each animat within the energy footprint of the event and calculates the number of animats having received levels of energy exposures that fall within defined impact thresholds. Predicted effects on the animats within a scenario are then tallied and the highest order effect (based on severity of criteria; e.g., PTS over TTS) predicted for a given animat is assumed. Each scenario or each 24-hour period for scenarios lasting greater than 24 hours is independent of all others, and therefore, the same individual marine animal could be impacted during each independent scenario or 24-hour period. In few instances, although the activities themselves all occur within the Study Area, sound may propagate beyond the boundary of the Study Area. Any exposures occurring outside the boundary of the Study Area are included in the model-estimated impacts for each alternative. The Navy Acoustic Effects Model provides the initial estimated impacts on marine species with a static horizontal distribution (based on application of multiple conservative assumptions, which are assumed to overestimate impacts), which are then further analyzed to account for pre-activity avoidance by sensitive species, mitigation (considering sound source and platform), and avoidance of repeated sound exposures by marine mammals, producing the final predictions of impacts used in the Navy's MMPA take requests and ESA risk analyses (Section 3.4.3.1.9.2, Avoidance Behavior and Mitigation Measures as Applied to Explosives, provides further information on additional analyses).

3.4.3.1.5.4 Model Assumptions and Limitations

There are limitations to the data used in the Navy Acoustic Effects Model, and the results must be interpreted with consideration for these known limitations. Output from the Navy Acoustic Effects Model relies heavily on the quality of both the input parameters and impact thresholds and criteria. When there was a lack of definitive data to support an aspect of the modeling (such as lack of well described diving behavior for all marine species), conservative assumptions believed to overestimate the number of exposures were chosen:

- Animats are modeled as being underwater and facing the source and therefore always predicted to receive the maximum sound level at their position within the water column (e.g., the model does not account for conditions such as body shading, porpoising out of the water, or an animal raising its head above water). Some odontocetes have been shown to have directional hearing, with best hearing sensitivity facing a sound source and higher hearing thresholds for sounds propagating toward the rear or side of an animal (Kastelein et al. 2005a; Mooney et al. 2008; Popov and Supin 2009).
- Animats do not move horizontally (but change their position vertically within the water column), which may overestimate physiological effects such as hearing loss, especially for slow moving or stationary sound sources in the model.
- Animats are stationary horizontally and therefore do not avoid the sound source, unlike in the wild where animals would most often avoid exposures at higher sound levels, especially those exposures that may result in PTS.
- Animats are assumed to receive the full impulse of the initial positive pressure wave due to an explosion, although the impulse-based thresholds (onset mortality and onset slight lung injury) assume an impulse delivery time adjusted for animal size and depth. Therefore, these impacts are overestimated at farther distances and increased depths.
- Multiple exposures within any 24-hour period are considered one continuous exposure for the purposes of calculating the temporary or permanent hearing loss, because there are not sufficient data to estimate a hearing recovery function for the time between exposures.
- Mitigation measures implemented during many training and testing activities were not considered in the model (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). In reality, sound-producing activities would be reduced, stopped, or delayed if marine mammals are detected within the mitigation zones around sound sources.

Because of these inherent model limitations and simplifications, model-estimated results must be further analyzed, considering such factors as the range to specific effects, avoidance, and the likelihood of successfully implementing mitigation measures. This analysis uses a number of factors in addition to the acoustic model results to predict acoustic effects on marine mammals (Section 3.4.3.1.8.2, Avoidance Behavior and Mitigation Measures as Applied to Sonar and Active Acoustic Sources, provides further information on additional analyses).

3.4.3.1.5.5 Marine Mammal Avoidance of Sound Exposures

Marine mammals may avoid sound exposures by either avoiding areas with high levels of anthropogenic activity or moving away from a sound source. Because the Navy Acoustic Effects Model does not consider horizontal movement of animats, including avoidance of human activity or sounds, it over-estimates the number of marine mammals that would be exposed to sound sources that could cause injury. Therefore, the potential for avoidance is considered in the post-model analysis. The consideration of avoidance during use of sonar and other active acoustic sources and during use of explosives is described below and discussed in more detail in Sections 3.4.3.1.8 (Impacts from Sonar and Other Active Acoustic Sources) and in Section 3.4.3.1.9 (Impacts from Explosives). A detailed explanation of this analysis is also provided in the technical report *Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for Atlantic Fleet Training and Testing* (U.S. Department of the Navy 2013b).

Avoidance of Human Activity

Cues preceding the commencement of an event (e.g., multiple vessel presence and movement, aircraft overflight) may result in some animals departing the immediate area, even before active sound sources begin transmitting. Harbor porpoises and beaked whales have been observed to be especially sensitive to human activity, which is accounted for by using a low threshold for behavioral disturbance due to exposure to sonars and other active acoustic sources. Both finless porpoises (Li et al. 2008) and harbor porpoises (Barlow et al. 1988; Evans et al. 1994; Palka and Hammond 2001; Polacheck and Thorpe 1990) routinely avoid and swim away from large motorized vessels. The vaquita, which is closely related to the harbor porpoise, appears to avoid large vessels at about 2,995 ft. (913 m) (Jaramillo-Legorreta et al. 1999). The assumption is that the harbor porpoise would respond similarly to large Navy vessels. Beaked whales have also been documented to exhibit avoidance of human activity (Pirotta et al. 2012; Tyack et al. 2011).

Therefore, for certain naval activities preceded by high levels of vessel activity (multiple vessels) or hovering aircraft, harbor porpoises and beaked whales are assumed to avoid the activity area prior to the start of a sound-producing activity. Model-estimated effects during these types of activities are adjusted so that high level sound impacts to harbor porpoises and beaked whales (those causing PTS during use of sonar and other active acoustic sources and those causing mortality due to explosives) are considered to be TTS and recoverable injury, respectively, due to animals moving away from the activity and into a lower effect range.

Avoidance of Repeated Exposures

Marine mammals would likely avoid repeated high level exposures to a sound source that could result in injury (i.e., PTS). Therefore, the model-estimated effects are adjusted to account for marine mammals swimming away from a sonar or other active sources and away from multiple explosions to avoid repeated high level sound exposures. Avoidance of repeated sonar exposures is discussed further in Section 3.4.3.1.8.2 (Avoidance Behavior and Mitigation Measures as Applied to Sonar and Other Active Acoustic Sources), and avoidance of repeated explosive exposures is discussed further in Section 3.4.3.1.9.2 (Avoidance Behavior and Mitigation Measures as Applied to Explosives).

3.4.3.1.5.6 Implementing Mitigation to Reduce Sound Exposures

The Navy implements mitigation measures (described in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) during sound-producing activities, including halting or delaying use of a sound source or explosives when marine mammals are observed in the mitigation zone. The Navy Acoustic Effects Model estimates acoustic effects without taking into account any shutdown or delay of the activity when marine mammals are detected; therefore, the model overestimates impacts to marine mammals within mitigation zones. The post-model analysis considers and quantifies the potential for mitigation to reduce the likelihood or risk of PTS due to sonar and other active acoustic sources and injuries and mortalities due to explosives. A detailed explanation of this analysis is provided in the technical report *Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for Atlantic Fleet Training and Testing* (U.S. Department of the Navy 2013b).

Two factors are considered when quantifying the effectiveness of mitigation: (1) the sightability of each species that may be present in the mitigation zone, which is affected by species-specific characteristics, and (2) 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. The mitigation zones proposed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) encompass the estimated ranges to injury (including the range to mortality for explosives) for a given source.

Mitigation is considered in the quantified reduction of model-predicted effects when the mitigation zone can be fully or mostly observed prior to and during a sound-producing activity. Mitigation for each activity is considered in its entirety, taking into account the different ways an event may take place (some events may have more than one scenario involving different mitigation zones, platforms, or number of Lookouts). The ability to observe the range to mortality (for explosive activities only) and the range to potential injury (for all sound-producing activities) was estimated for each training or testing event. Mitigation was considered in the acoustic analysis as follows:

- If the entire mitigation zone can be continuously visually observed based on the platform(s), number of Lookouts, and size of the range to effects zone, the mitigation is considered fully effective (Effectiveness = 1).
- If over half of the mitigation zone can be continuously visually observed or if there is one or more of the scenarios within the activity for which the mitigation zone cannot be continuously visually observed (but the range to effects zone can be visually observed for the majority of the scenarios), the mitigation is considered mostly effective (Effectiveness = 0.5).
- If less than half of the mitigation zone can be continuously visually observed or if the mitigation zone cannot be continuously visually observed during most of the scenarios within the activity due to the type of surveillance platform(s), number of Lookouts, and size of the mitigation zone, the mitigation is not considered in the quantified reduction of model predicted acoustic effects.

The ability of Navy Lookouts to detect marine mammals 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. The Navy considered what applicable data were available to numerically approximate the sightability of marine mammals and determined that the standard "detection probability" referred to as g(0) was most appropriate. The abundance of marine mammals is typically estimated using line-transect analyses (Buckland et al. 2001), in which g(0) is the probability of detecting an animal or group of animals on the transect line (the straight-line course of the survey ship or aircraft). This detection probability is derived from systematic line-transect marine mammal surveys based on species-specific estimates for vessel and aerial platforms. Estimates of g(0) are available from peer-reviewed marine mammal line-transect survey reports, generally provided through research conducted by the National Marine Fisheries Service Science Centers. The g(0) values used in this analysis are provided in Section 5.3.1.2.4.1 (Detection Probabilities of Marine Mammals in the Study Area).

There are two separate components of g(0): perception bias and availability bias (Marsh and Sinclair 1989). Perception bias accounts for marine mammals that are on the transect line and detectable, but were simply missed by the observer. Various factors influence the perception bias component of g(0), including species-specific characteristics (e.g., behavior and appearance, group size, and blow characteristics), viewing conditions during the survey (e.g., sea state, wind speed, wind direction, wave height, and glare), observer characteristics (e.g., experience, fatigue, and concentration), and platform characteristics (e.g., pitch, roll, speed, and height above water). To derive estimates of perception bias, typically an independent observer is present who looks for marine mammals missed by the primary observers. Mark-recapture methods are then used to estimate the probability that animals are missed by the primary observers. Availability bias accounts for animals that are missed because they are not at the surface at the time the survey platform passes by, which generally occurs more often with deep diving whales (e.g., sperm whale and beaked whale). The availability bias portion of g(0) is independent of prior marine mammal detection experience since it only reflects the probability of an animal being at the surface within the survey track and therefore available for detection.

Some g(0) values are estimates of perception bias only, some are estimates of availability bias only, and some reflect both, depending on the species and data currently available. The Navy used g(0) values with both perception and availability bias components if those data were available. If both components were not available for a particular species, the Navy determined that g(0) values reflecting perception bias or availability bias, but not both, still represented the best statistically derived factor for assessing the likelihood of marine mammal detection by Navy Lookouts.

As noted above, line-transect surveys and subsequent analyses are typically used to estimate cetacean abundance. To systematically sample portions of an ocean area (such as the coastal waters off California or the east coast), marine mammal surveys are designed to uniformly cover the survey area and are conducted at a constant speed (generally 10 knots for ships and 100 knots for aircraft). Survey transect lines typically follow a pattern of straight lines or grids. Generally there are two primary observers searching for marine mammals. Each primary observer looks for marine mammals in the forward 90-degree quadrant on their side of the survey platform. Based on data collected during the survey, scientists determine the factors that affected the detection of an animal or group of animals directly along the transect line.

Visual marine mammal surveys (used to derive g(0)) are conducted during daylight[1]. Marine mammal surveys are typically scheduled for a season when weather at sea is more likely to be good; however, observers on marine mammal surveys will generally collect data in sea-state conditions up to Beaufort 6 and do encounter rain and fog at sea, which may also reduce marine mammal detections (Barlow 2006). For most species, g(0) values are based on the detection probability in conditions from Beaufort 0 to Beaufort 5, which reflect the fact that marine mammal surveys are often conducted in less than ideal conditions (Barlow 2003; Barlow and Forney 2007). The ability to detect some species (e.g., beaked whales, *Kogia* spp., and Dall's porpoise) decreases dramatically with increasing sea states, so g(0) estimates for these species are usually restricted to observations in sea-state conditions of Beaufort 0 to 2 (Barlow 2003).

Navy training and testing events differ from systematic line-transect marine mammal surveys in several respects. These differences suggest the use of g(0), as a sightability factor to quantitatively adjust model-predicted effects based on mitigation, is likely to result in an underestimate of the protection afforded by the implementation of mitigation as follows:

- Mitigation zones for Navy training and testing events are significantly smaller (typically less than 1,000 yd. radius) than the area typically searched during line-transect surveys, which includes the maximum viewable distance out to the horizon.
- In some cases, Navy events can involve more than one vessel or aircraft (or both) operating in proximity to each other or otherwise covering the same general area. Additional vessels and

[1] At night, passive acoustic data may still be collected during a marine mammal survey.

aircraft can result in additional watch personnel observing the mitigation zone (e.g., ship shock trials). This would result in more observation platforms and observers looking at the mitigation zone than the two primary observers used in marine mammal surveys upon which g(0) is based.

- A systematic marine mammal line-transect survey is designed to sample broad areas of the ocean, and generally does not retrace the same area during a given survey. Therefore, in terms of g(0), the two primary observers have only a limited opportunity to detect marine mammals that may be present during a single pass along the trackline (i.e., deep diving species may not be present at the surface as the survey transits the area). In contrast, many Navy training and testing activities involve area-focused events (e.g., anti-submarine warfare tracking exercise), where participants are likely to remain in the same general area during an event. In other cases Navy training or testing activities are stationary (i.e., pierside sonar testing or use of dipping sonar), which allow Lookouts to focus on the same area throughout the activity. Both of these circumstances result in a longer observation period of a focused area with more opportunities for detecting marine mammals than are offered by a systematic marine mammal line-transect survey that only passes through an area once.

Although Navy Lookouts on ships have hand-held binoculars and on some ships, pedestal-mounted binoculars very similar to those used in marine mammal surveys, there are differences between the scope and purpose of marine mammal detections during research surveys along a trackline and Navy Lookouts observing the water near a Navy training or testing activity to facilitate implementation of mitigation. The distinctions require careful consideration when comparing the Navy Lookouts to marine mammal surveys.[2]

- A marine mammal observer is responsible for detecting marine mammals in their quadrant of the trackline out to the limit of the available optics. Although Navy Lookouts are responsible for observing the water for safety of ships and aircraft, during specific training and testing activities, they need only detect marine mammals in the relatively small area that surrounds the mitigation zone (in most cases less than 1,000 yd. from the ship) for mitigation to be implemented.
- Navy Lookouts, personnel aboard aircraft and on watch onboard vessels at the surface will have less experience detecting marine mammals than marine mammal observers used for line-transect survey. However, Navy personnel responsible for observing the water for safety of ships and aircraft do have significant experience looking for objects (including marine mammals)

[2] Barlow and Gisiner (2006) provide a description of typical marine mammal survey methods from ship and aircraft and then provide "a crude estimate" of the difference in detection of beaked whales between trained marine mammal observers and seismic survey mitigation, which is not informative with regard to Navy mitigation procedures for the following reasons. The authors note that seismic survey differs from marine mammal surveys in that, "(1) seismic surveys are also conducted at night; (2) seismic surveys are not limited to calm sea conditions; (3) mitigation observers are primarily searching with unaided eyes and 7x binoculars; and (4) typically only one or possibly two observers are searching." When Navy implements mitigation for which adjustments to modeling output were made, the four conditions Barlow and Gisiner (2006) note are not representative of Navy procedures nor necessarily a difference in marine mammal line-transect survey procedures. The Navy accounts for reduced visibility (i.e., activities that occur at night, etc.) by assigning a lower value to the mitigation effectiveness factor. On Navy ships, hand-held binoculars are always available, and pedestal mounted binoculars, very similar to those used in marine mammal surveys, are generally available to Navy Lookouts on board vessels over 60 ft. Also, like marine mammal observers, Navy Lookouts are trained to use a methodical combination of unaided eye and optics as they search the surface around a vessel. The implication that marine mammal surveys only occur in "calm sea conditions" is not accurate since the vast majority of marine mammal surveys occur in conditions up to sea states of Beaufort 5. The specific g(0) values analyzed by Barlow and Gisiner (2006) were derived from survey data for Cuvier's and *Mesoplodon* beaked whales detected in sea states of Beaufort 0-2 during daylight hours. However, marine mammal surveys are not restricted to sea states of Beaufort 0-2 and many species' g(0) values are based on conditions up to and including Beaufort 5; therefore, the conclusions reached by Barlow and Gisiner (2006) regarding the effect of sea state conditions on sightability do not apply to other species. Finally, when Lookouts are present, there are always more than the "one or two personnel" described by Barlow and Gisiner (2006) observing the area ahead of a Navy vessel (additional bridge watch personnel are also observing the water around the vessel).

on the water's surface and Lookouts are trained using the NMFS-approved Marine Species Awareness Training.

Although there are distinct differences between marine mammal surveys and Navy training and testing, the use of g(0) as an approximate sightability factor for quantitatively adjusting model-predicted impacts due to mitigation (mitigation effectiveness x g(0)) is an appropriate use of the best available science based on the way it has been applied. Consistent with the Navy's impact assessment processes, the Navy applied g(0) in a conservative manner (erring on the side of overestimating the number of impacts) to quantitatively adjust model-predicted effects to marine mammals within the applicable mitigation zones during Navy training and testing activities. Conservative application of g(0) includes:

- In addition to a sightability factor (based on g(0)), the Navy also applied a mitigation effectiveness factor to acknowledge the uncertainty associated with applying the g(0) values derived from marine mammal surveys to specific Navy training and testing activities where the ability to observe the whole mitigation zone is less than optimal (generally due to the size of the mitigation zone).
- For activities that can be conducted at night, the Navy assigned a lower value to the mitigation effectiveness factor. For example, if an activity can take place at night half the time, then the mitigation effectiveness factor was only given a value of 0.5.
- The Navy did not quantitatively adjust model-predicted effects for activities that were given a mitigation effectiveness factor of zero. A mitigation effectiveness factor of zero was given to activities where less than half of the mitigation zone can be continuously visually observed or if the mitigation zone cannot be continuously visually observed during most of the scenarios within the activity due to the type of surveillance platform(s), number of Lookouts, and size of the mitigation zone. However, some protection from applied mitigation measures would be afforded during these activities, even though it is not accounted for in the quantitative reduction of model-predicted impacts.
- The Navy did not quantitatively adjust model-predicted effects based on detections made by other personnel that may be involved with an event (such as range support personnel aboard a torpedo retrieval boat or support aircraft), even though information about marine mammal sightings are shared among units participating in the training or testing activity. In other words, the Navy only quantitatively adjusted the model-predicted effects based on the required number of Lookouts.
- The Navy only quantitatively adjusted model-predicted effects within the range to mortality (explosives only) and injury (all sound-producing activities), and not for the range to TTS or other behavioral effects (See Table 5.3-2 for a comparison of the range to effects for PTS, TTS, and the recommended mitigation zone). Despite employing the required mitigation measures during an activity that will also reduce some TTS exposures, the Navy did not quantitatively adjust the model-predicted TTS effects as a result of implemented mitigation.
- The total model-predicted number of animals affected is not reduced by the post-model mitigation analysis, since all reductions in mortality and injury effects are then added to and counted as TTS effects.
- Mitigation involving a power-down or cessation of sonar, or delay in use of explosives, as a result of a marine mammal detection, protects the observed animal and all unobserved (below the surface) animals in the vicinity. The quantitative adjustments of model-predicted impacts, however, assume that only animals on the water surface, approximated by considering the

species-specific g(0) and activity-specific mitigation effectiveness factor, would be protected by the applied mitigation (i.e., a power down or cessation of sonar or delaying the event). The quantitative post-model mitigation analysis, therefore, does not capture the protection afforded to all marine mammals that may be near or within the mitigation zone.

The Navy recognizes that g(0) values are estimated specifically for line-transect analyses; however, g(0) is still the best statistically derived factor for assessing the likely marine mammal detection abilities of Navy Lookouts. Based on the points summarized above, as a factor used in accounting for the implementation of mitigation, g(0) is therefore considered to be the best available scientific basis for the Navy's representation of the sightability of a marine mammal as used in this analysis.

The post-model acoustic effects quantification process is summarized in Table 3.4-8. In brief, the mitigation effectiveness score for an event is multiplied by the estimated sightability of each species to quantify the number of animals originally modeled as a mortality (explosives only) or injury (all sound-producing activities) exposure but would, in reality, be observed by Lookouts prior to or during a sound-producing activity. Observation of marine mammals prior to or during a sound-producing activity would be followed by stop or delay of the sound-producing activity, which would reduce actual marine mammal sound exposures. The consideration of mitigation during use of sonar and other active acoustic sources and during use of explosives is discussed in more detail in Section 3.4.3.1.8 (Impacts from Sonar and Other Active Acoustic Sources) and Section 3.4.3.1.9 (Impacts from Explosions).

The incorporation of mitigation factors for the reduction of predicted exposures used a conservative approach (erring on the side of overestimating the number of exposures) since reductions as a result of implemented mitigation were only applied to those events having a very high likelihood of detecting marine mammals. It is important to note that there are additional protections offered by mitigation measures that will further reduce exposures to marine mammals, but are not considered in the quantitative adjustment of the model-predicted effects.

3.4.3.1.6 Marine Mammal Monitoring During Navy Training

The current behavioral exposure criteria under the response function also assumes there will be a range of reactions from minor or inconsequential to severe. Section 3.0.2.2 (Navy Integrated Comprehensive Monitoring Program) summarizes the monitoring data that has been collected thus far within the Study Area. Results of monitoring may provide indications that the severity of reactions has also been overestimated.

Table 3.4-8: Post-Model Acoustic Impact Analysis Process

Is the Sound Source Sonar/Other Active Acoustic Source or Explosives?	
Sonar and Other Active Acoustic Sources	**Explosives**
S-1. Is the activity preceded by multiple vessel activity or hovering helicopter?	**E-1. Is the activity preceded by multiple vessel activity or hovering helicopter?**
Species sensitive to human activity (i.e., harbor porpoises and beaked whales) are assumed to avoid the activity area, putting them out of the range to Level A harassment. Model-estimated PTS to these species during these activities are unlikely to actually occur and, therefore, are considered to be TTS (animal is assumed to move into the range of potential TTS). The activities preceded by multiple vessel movements or hovering helicopters are listed in Table 3.4-11 in 3.4.3.2 (Avoidance Behavior and Mitigation Measures as Applied to Sonar and Other Active Acoustic Sources).	Species sensitive to human activity (i.e., harbor porpoises and beaked whales) are assumed to avoid the activity area, putting them out of the range to mortality. Model-estimated mortalities to these species during these activities are unlikely to actually occur and, therefore, are considered to be injuries (animal is assumed to move into the range of potential injury). The activities preceded by multiple vessel movements or hovering helicopters are listed in Table 3.4-23 in Section 3.4.3.1.9.2 (Avoidance Behavior and Mitigation as Applied to Explosives).
S-2. Can Lookouts observe the activity-specific mitigation zone (see Chapter 5) up to and during the sound-producing activity?	**E-2. Can Lookouts observe the activity-specific mitigation zone (see Chapter 5) up to and during the sound-producing activity?**
If Lookouts are able to observe the mitigation zone up to and during a sound-producing activity, the sound-producing activity would be halted or delayed if a marine mammal is observed and would not resume until the animal is thought to be out of the mitigation zone (per the mitigation measures in Chapter 5). Therefore, model-estimated PTS exposures are reduced by the portion of animals that are likely to be seen [Mitigation Effectiveness (1, 0.5, or 0) x Sightability, g(0)]. Any animals removed from the model-estimated PTS are instead assumed to be TTS (animal is assumed to move into the range of TTS). The g(0) value is associated with the platform (vessel or aircraft) with the dedicated Lookout(s). For activities with lookouts on both platforms, the higher g(0) is used for analysis. The g(0) values are provided in Table 5.3-1. The Mitigation Effectiveness values are provided in Table 3.4-12 in Section 3.4.3.1.8.2 (Avoidance Behavior and Mitigation Measures as Applied to Sonar and Other Active Acoustic Sources).	If Lookouts are able to observe the mitigation zone up to and during an explosion, the explosive activity would be halted or delayed if a marine mammal is observed and would not resume until the animal is thought to be out of the mitigation zone (per the mitigation measures in Chapter 5). Therefore, model-estimated mortalities and injuries are reduced by the portion of animals that are likely to be seen [Mitigation Effectiveness (1, 0.5, or 0) x Sightability, g(0)]. Any animals removed from the model-estimated mortalities or injuries are instead assumed to be injuries or behavioral disturbances, respectively (animals are assumed to move into the range of a lower effect). The g(0) value is associated with the platform (vessel or aircraft) with the dedicated Lookout(s). For activities with lookouts on both platforms, the higher g(0) is used for analysis. The g(0) values are provided in Table 5.3-1. The Mitigation Effectiveness values for explosive activities are provided in Table 3.4-24 in Section 3.4.3.1.9.2 (Avoidance Behavior and Mitigation as Applied to Explosives).

Table3.4-8: Post-Model Acoustic Impact Analysis Process (Continued)

Is the Sound Source Sonar/Other Active Acoustic Source or Explosives?	
Sonar and Other Active Acoustic Sources	**Explosives**
S-3. Does the activity cause repeated sound exposures which an animal would likely avoid?	**E-3. Does the activity cause repeated sound exposures which an animal would likely avoid?**
The Navy Acoustic Effects Model assumes that animals do not move away from a sound source and receive a maximum sound exposure level. In reality, an animal would likely avoid repeated sound exposures that would cause PTS by moving away from the sound source. Therefore, only the initial exposures resulting in model-estimated PTS to high-frequency cetaceans, low frequency cetaceans, and phocids are expected to actually occur (after accounting for mitigation in step S-3). Model estimates of PTS beyond the initial pings are considered to actually be TTS, as the animal is assumed to move out of the range to PTS and into the range of TTS. Marine mammals in the mid-frequency hearing group would have to be close to the most powerful moving source (less than 10 m) to experience PTS. These model-estimated PTS exposures of mid-frequency cetaceans are unlikely to actually occur and, therefore, are considered to be TTS (animal is assumed to move into the range of TTS).	The Navy Acoustic Effects Model assumes that animals do not move away from multiple explosions and receive a maximum sound exposure level. In reality, an animal would likely avoid repeated sound exposures that would cause PTS by moving away from the site of multiple explosions. Therefore, only the initial exposures resulting in model-estimated PTS are expected to actually occur (after accounting for mitigation in step E-2). Model estimates of PTS are reduced to account for animals moving away from an area with multiple explosions, out of the range to PTS, and into the range of TTS. Activities with multiple explosions are listed in Table 3.4 25 in Section 3.4.3.1.9.2 (Avoidance Behavior and Mitigation as Applied to Explosives).

m: meters; PTS: permanent threshold shift; TTS: temporary threshold shift

3.4.3.1.7 Application of the Marine Mammal Protection Act and Endangered Species Act to Potential Acoustic and Explosive Effects

3.4.3.1.7.1 Marine Mammal Protection Act

The MMPA prohibits the unauthorized harassment of marine mammals and provides the regulatory processes for authorization for any such incidental harassment that might occur during an otherwise lawful activity. Harassment that may result from Navy training and testing activities described in this EIS/OEIS is unintentional and incidental to those activities.

For military readiness activities, MMPA Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. Injury, as defined in this EIS/OEIS, is the destruction or loss of biological tissue from a species. The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue. For example, increased localized histamine production, edema, production of scar tissue, activation of clotting factors, white blood cell response, etc., may be expected following injury. Therefore, this EIS/OEIS assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and rulings, all injuries (slight to severe) are considered MMPA Level A harassment.

PTS is non-recoverable and, by definition, results from the irreversible impacts on auditory sensory cells, supporting tissues, or neural structures within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the wording of the MMPA. The smallest amount of PTS (onset-PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset-PTS is used to define the outer limit of the MMPA Level A exposure zone. Model predicted slight lung injury and gastrointestinal tract injuries are also considered MMPA Level A harassment in this analysis.

Public Law 108-136 (2004) amended the MMPA definitions of Level B harassment for military readiness activities to be "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered." Unlike MMPA Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause MMPA Level B harassment.

TTS is recoverable and is considered to result from the temporary, noninjurious fatigue of hearing-related tissues. The smallest measurable amount of TTS (onset-TTS) is taken as the best indicator for slight temporary sensory impairment. Because it is considered non-injurious, the acoustic exposure associated with onset-TTS is used to define the outer limit of the portion of the MMPA Level B exposure zone attributable to physiological effects. Short-term reduction in hearing acuity could be considered a temporary decrement similar in scope to a period of hearing masking or behavioral disturbance. As such, it is considered by the Navy and NMFS as a Level B effect overlapping the range of sounds producing behavioral effects.

The harassment status of slight behavior disruption has been addressed in workshops, previous actions, and rulings (National Oceanic and Atmospheric Administration 2008). The conclusion is that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic event does not qualify as MMPA Level B harassment. This analysis uses behavioral criteria to predict the number of animals likely to experience a significant behavioral reaction, and therefore an MMPA Level B harassment.

NMFS also includes mortality as a possible outcome to consider in addition to MMPA Level A and Level B harassment. An individual animal predicted to experience simultaneous multiple injuries, multiple disruptions, or both, is counted as a single take (National Oceanic and Atmospheric Administration 2008). NMFS has generally identified a 24-hour period as the amount of time in which an individual can be harassed no more than once. Behavioral harassment, under the risk function presented in this analysis, uses the highest received sound pressure level over a 24-hour period as the metric for determining the probability of a behavioral harassment.

3.4.3.1.7.2 Endangered Species Act

Generalized information on definitions and the application of the ESA are presented in Section 3.0 (Introduction) along with the acoustic conceptual framework used in this analysis. Consistent with NMFS analysis for Section 7 consultation under the ESA (see National Marine Fisheries Service 2007), the spatial and temporal overlap of activities with the presence of listed species is assessed in this EIS/OEIS. The definitions used by the Navy in making the determination of effect under Section 7 of the ESA are based on the U.S. Fish and Wildlife Service and NMFS *Endangered Species Consultation Handbook* (United States Fish and Wildlife Service and National Marine Fisheries Service 1998), and recent NMFS Biological Opinions involving many of the same activities and species.

- "No effect" is the appropriate conclusion when a listed species or its designated critical habitat will not be affected, either because the species will not be present or because the project does not have any elements with the potential to affect the species or modify designated critical habitat. “No effect” does not include a small effect or an effect that is unlikely to occur.

- If a stressor and species presence overlap, but predicted effects are insignificant (in size) or discountable (extremely unlikely), a “may affect, but not likely to adversely affect” determination is appropriate. "May affect" is appropriate when animals are within a range where they could potentially detect or otherwise be affected by the sound (e.g., the sound is above background ambient levels).
  - Insignificant effects relate to the size of the impact and should never reach the scale where take occurs.
  - Discountable effects are those extremely unlikely to occur and based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.
- If a stressor and species presence overlap, and a predicted effect is not insignificant, discountable, or beneficial, a “may affect, likely to adversely affect” determination is appropriate.

There are no harassment or injury criteria established for marine mammals under the ESA because the ESA requires an assessment starting with mere exposure potential. Acoustic modeling is used to predict the number of ESA-listed marine mammals exposed to sound resulting from Navy training and testing activities, without any behavioral or physiological criteria applied.

3.4.3.1.8 Impacts from Sonar and Other Active Acoustic Sources

Sonar and other active acoustic sources proposed for use are transient in most locations as active sonar activities move throughout the Study Area. Sonar and other active acoustic sound sources emit sound waves into the water to detect objects, safely navigate, and communicate. General categories of sonar systems are described in Section 2.3.7 (Classification of Acoustic and Explosive Sources).

Exposure of marine mammals to non-impulsive sources such as active sonar is not likely to result in primary blast injuries or barotraumas. Sonar induced acoustic resonance and bubble formation phenomena are also unlikely to occur under realistic conditions in the ocean environment, as discussed in Section 3.4.3.1.2.1 (Direct Injury). Direct injury from sonar and other active acoustic sources would not occur under conditions present in the natural environment and therefore is not considered further in this analysis.

Research and observations of auditory masking in marine mammals is discussed in Section 3.4.3.1.2.3 (Auditory Masking). Anti-submarine warfare sonar can produce intense underwater sounds in the Study Area associated with the Proposed Action. These sounds are likely within the audible range of most cetaceans but are normally very limited in the temporal, frequency, and spatial domains. The duration of individual sounds is short; sonar pulses can last up to a few seconds each, but most are shorter than 1 second. The duty cycle is low, with most tactical anti-submarine warfare sonar typically transmitting about once per minute. Furthermore, events are geographically and temporally dispersed, and most events are limited to a few hours. Tactical sonar has a narrow frequency band (typically less than one-third octave). These factors reduce the likelihood of sources causing significant auditory masking in marine mammals.

Some object-detecting sonar (i.e., mine warfare sonar) has a high duty cycle producing up to a few pings per second. Such sonar typically employs high frequencies (above 10 kHz) that attenuate rapidly in the water, thus producing only a small area of potential auditory masking. Higher-frequency mine warfare sonar systems are typically outside the hearing and vocalization ranges of mysticetes (Section 3.4.2.3, Vocalization and Hearing of Marine Mammals); therefore, mysticetes are unlikely to be able to detect the higher frequency mine warfare sonar, and these systems would not interfere with their communication or detection of biologically relevant sounds. Odontocetes may experience some limited masking at closer ranges as the frequency band of many mine warfare sonars overlap the hearing and vocalization abilities of some odontocetes; however, the frequency band of the sonar is narrow, limiting the likelihood of auditory masking. With any of these activities, the limited duration and dispersion of the activities in space and time reduce the potential for auditory masking effects from proposed activities on marine mammals.

The most probable effects from exposure to sonar and other active acoustic sources are PTS, TTS, and behavioral harassment (Sections 3.4.3.1.2.2, Hearing Loss, and 3.4.3.1.2.5, Behavioral Reactions). The Navy Acoustic Effects Model is used 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. These are discussed below in the following sections.

Another concern is the number of times an individual marine mammal is exposed and potentially reacts to a sonar or other active acoustic source over the course of a year or within a specific geographic area. Animals that are resident during all or part of the year near Navy ports or on fixed Navy ranges are the most likely to experience multiple exposures. Repeated and chronic noise exposures to marine mammals and their observed reactions are discussed in this analysis where applicable.

3.4.3.1.8.1 Range to Effects

The following section provides the range (distance) over which specific physiological or behavioral effects are expected to occur based on the acoustic criteria (Section 3.4.3.1.4, Thresholds and Criteria for Predicting Acoustic and Explosive Impacts) and the acoustic propagation calculations from the Navy Acoustic Effects Model (Section 3.4.3.1.5.3, Navy Acoustic Effects Model). Although the Navy uses various sonar and active acoustic sources, the sonar bins provided below (i.e., MF1, MF4, and MF5) represent three of the most powerful sources. These sonar bins are often the dominant source in the activity in which they are included, especially for smaller unit-level training exercises and many testing activities. Therefore, these ranges provide realistic maximum distances over which the specific effects would be possible.

The range to specific effects are used to assess model results and determine adequate mitigation ranges to avoid higher level effects, especially physiological effects. Additionally, these data can be used to analyze the likelihood of an animal being able to avoid an oncoming sound source by simply moving a short distance (i.e., within a few hundred meters). Figure 3.4-8 shows a representation of effects with distance from a hypothetical sonar source; notice the proportion of animals that are likely to have a behavioral response (yellow block; “response-function”) decreases with increasing distance from the source.

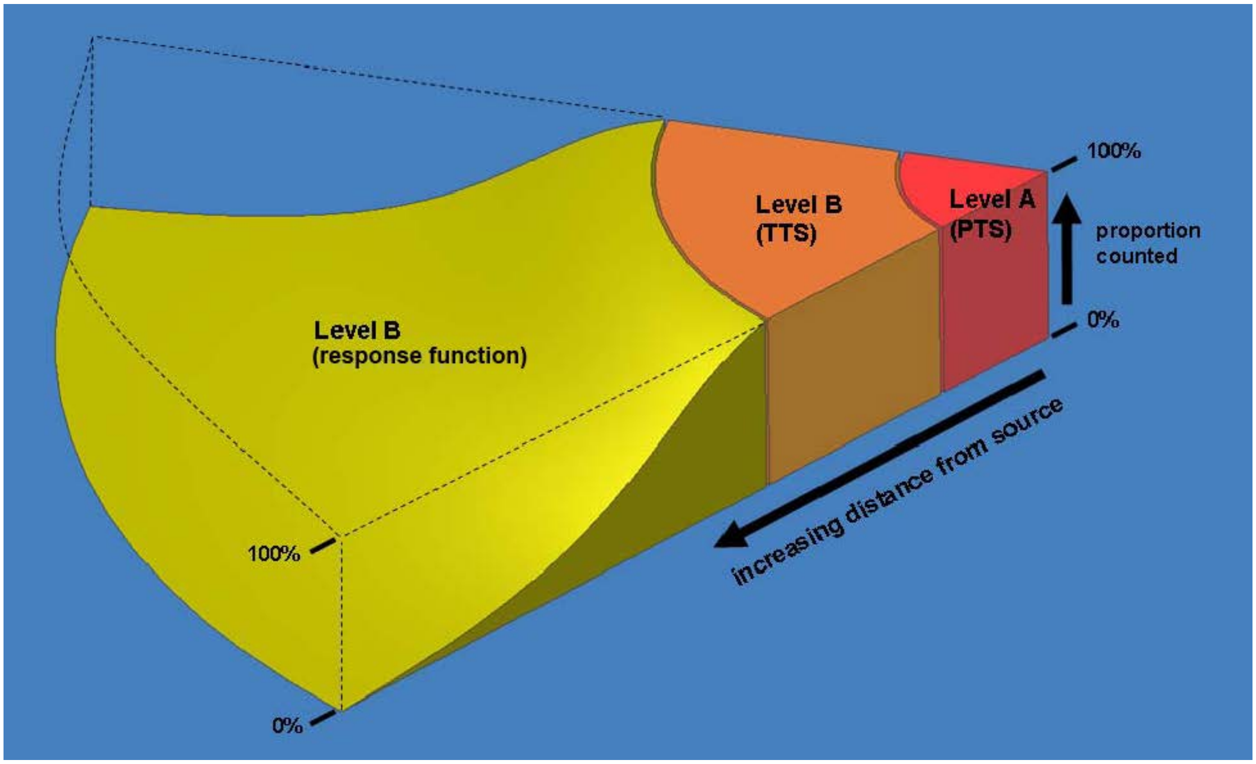


Figure 3.4-8: Hypothetical Range to Specified Effects for a Sonar Source
PTS: permanent threshold shift; TTS: temporary threshold shift; %: percent

The ranges to the PTS threshold (i.e., range to the onset of PTS: the maximum distance to which PTS would be expected) are shown in Table 3.4-9 relative to the marine mammal's functional hearing group. For a SQS-53 sonar transmitting for 1 second at 3 kHz and a representative source level of 235 dB re 1 µPa^2-s at 1 m, the range to PTS for the most sensitive species (the high-frequency cetaceans) extends from the source to a range of 100 m (110 yd.). Since any hull mounted sonar, such as the SQS-53, engaged in anti-submarine warfare training would be moving at between 10–15 knots (5.1–7.7 m/second) and nominally pinging every 50 seconds, the vessel will have traveled a minimum distance of approximately 260 m (280 yd.) during the time between those pings (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 functional hearing groups (low-frequency cetaceans, mid-frequency cetaceans, and phocid seals and manatees) single-ping PTS zones are within 100 m of the sound source. A scenario could occur where an animal does not leave the vicinity of a ship or travels a course parallel to the ship within the PTS zone; however, as indicated in Table 3.4-9, the distances required make PTS exposure less likely. 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. For all sources except hull-mounted sonar (e.g., SQS-53 and BQQ-10) ranges to PTS are well within 50 m (55 yd.), even for multiple pings (up to five pings) and the most sensitive functional hearing group (high-frequency cetaceans).

Table 3.4-9: Approximate Ranges to Permanent Threshold Shift Criteria for Each Functional Hearing Group for a Single Ping from Three of the Most Powerful Sonar Systems within Representative Ocean Acoustic Environments

Functional Hearing Group	Ranges to the Onset of PTS for One Ping (meters)[1]		
	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)
Low-Frequency Cetaceans	70	10	≤ 2
Mid-Frequency Cetaceans	10	≤ 2	≤ 2
High-Frequency Cetaceans	100	20	10
Phocid Seals and Manatees	80	10	≤ 2

ASW: anti-submarine warfare; PTS: permanent threshold shift

[1] Approximate ranges are based on spherical spreading (Transmission Loss = 20 log R, where R = range in meters).

Table 3.4-10 illustrates the ranges to the onset of TTS (i.e., the maximum distances to which TTS would be expected) for one, five, and ten pings from four representative sonar systems. Due to the lower acoustic thresholds for TTS versus PTS, ranges to TTS are longer. Therefore, it is possible for animals to remain in these areas over several successive pings and potentially suffer TTS.

Table 3.4-10: Approximate Ranges to the Onset of Temporary Threshold Shift for Four Representative Sonar Systems Over a Representative Range of Ocean Environments

Functional Hearing Group	Approximate Ranges to the Onset of TTS (meters)[1]											
	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., SQQ-32; MIW Sonar)		
	One Ping	Five Pings	Ten Pings	One Ping	Five Pings	Ten Pings	One Ping	Five Pings	Ten Pings	One Ping	Five Pings	Ten Pings
Low-Frequency Cetaceans	560–2,280	1,230–6,250	1,620–8,860	220–240	490–1,910	750–2,700	110–120	240–310	340–1,560	100–160	150–730	150–820
Mid-Frequency Cetaceans	150–180	340–440	510–1,750	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
High-Frequency Cetaceans	2,170–7,570	4,050–15,350	5,430–19,500	90	180–190	260–950	< 50	< 50	< 50	< 50	< 50	< 50
Phocid Seals and Manatees	72–1,720	200–3,570	350–4,850	< 50	100	150	< 50	< 50	< 50	< 50	< 50	< 50

ASW: anti-submarine warfare; MIW: mine warfare; TTS: temporary threshold shift

[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 receive TTS extends from onset-PTS to the distance indicated.

The distances over which the sound pressure level from four representative sonar sources is within the indicated 10-dB bins, and the percentage of animals that may exhibit a significant behavioral response under the mysticete and odontocete behavioral response function, are shown in Table 3.4-11 and Table 3.4-12, respectively. Section 3.4.3.1.4.5 (Behavioral Responses) provides details on the derivation and use of the behavioral response function as well as the step function thresholds for harbor porpoises and beaked whales of 120 dB re 1 µPa and 140 dB re 1 µPa, respectively.

Range to 120 dB re 1 µPa varies by system but can exceed 180 km (100 nm) for the most powerful hull-mounted sonar; however, only a very small percentage of animals would be predicted to react at received levels between 120 and 130 dB re 1 µPa, with the exception of harbor porpoises. All harbor porpoises that are predicted to receive 120 dB re 1 µPa or greater would be assumed to exhibit a behavioral response. Likewise, beaked whales would be predicted to have behavioral reactions at distances to approximately 79 km (43 nm).

3.4.3.1.8.2 Avoidance Behavior and Mitigation Measures as Applied to Sonar and Active Acoustic Sources

As discussed above (Section 3.4.3.1.5.4, Model Assumptions and Limitations), within the Navy Acoustic Effects Model, animats (virtual animals) do not move horizontally or react in any way to avoid sound at any level. In reality, various researchers have demonstrated that cetaceans can perceive the location and movement of a sound source (e.g., vessel, seismic source, etc.) relative to their own location and react with responsive movement away from the source, often at distances of a kilometer or more (Au and Perryman 1982; Jansen et al. 2010; Richardson et al. 1995; Tyack et al. 2011; Watkins 1986; Wursig et al. 1998). Section 3.4.3.1.2.5 (Behavioral Reactions) reviews research and observations of marine mammals' reactions to sound sources including sonar, ships, and aircraft. At close ranges and high sound levels approaching those that could cause PTS, avoidance of the area immediately around the sound source is the assumed behavioral response for most cases. Additionally, the Navy Acoustic Effects Model does not account for the implementation of mitigation, which would prevent many of the model-estimated PTS effects. Therefore, the model-estimated PTS effects due to sonar and other active acoustic sources are further analyzed considering avoidance and implementation of mitigation measures described in Section 3.4.3.1.5 (Quantitative Analysis) and in the technical report *Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for Atlantic Fleet Training and Testing* (U.S. Department of the Navy 2013b).

If sound-producing activities are preceded by multiple vessel traffic or hovering aircraft, harbor porpoises and beaked whales are assumed to move beyond the range to PTS before sound transmission begins, as discussed in Section 3.4.3.1.5.5 (Marine Mammal Avoidance of Sound Exposures). Table 3.4-9 shows the ranges to PTS for several sonar systems, including the most powerful system, the AN/SQS-53 in bin MF1. The range to PTS for all systems is generally much less than 50 m, with the exception of low-frequency cetaceans, high-frequency cetaceans, and phocids exposed to bin MF1 (range to PTS less than or equal to 100 m). Because the Navy Acoustic Effects Model does not include avoidance behavior, the model-estimated effects are based on unlikely behavior for these species- that they would tolerate staying in an area of high human activity. Harbor porpoises and beaked whales that were model-estimated to experience PTS due to sonar and other active acoustic sources are assumed to actually move into the range of TTS prior to the start of the sound-producing activity for the activities listed in Table 3.4-13. For activities where multiple vessel traffic or hovering aircraft do not proceed the sound transmissions, model predicted PTS was not reduced based on this factor.

Table 3.4-11: Range to 10-dB Bins and Percentage of Behavioral Harassments in Each Bin for Low-Frequency Cetaceans under the Mysticete Behavioral Risk Function for Four Representative Sonar Systems

Received Level in 10-dB Bins	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., SQQ-32; MIW Sonar)	
	Distance Over Which Levels Occur (m)	Percentage of Behavioral Harassments Occurring at Given Levels	Distance Over Which Levels Occur (m)	Percentage of Behavioral Harassments Occurring at Given Levels	Distance Over Which Levels Occur (m)	Percentage of Behavioral Harassments Occurring at Given Levels	Distance Over Which Levels Occur (m)	Percentage of Behavioral Harassments Occurring at Given Levels
120 <= SPL <130	179,213 – 137,850	0.00%	60,983 – 22,117	0.00%	19,750 – 11363	0.00%	3,338 – 1,875	0.00%
130 <= SPL <140	137,850 – 78,100	0.30%	22,117 – 15,525	0.62%	11,363 – 4463	4.06%	1,875 – 1,013	1.73%
140 <= SPL <150	78,100 – 66,475	2.33%	15,525 – 5,300	31.36%	4,463 – 1,375	39.59%	1,013 – 300	38.25%
150 <= SPL <160	66,475 – 15,825	76.00%	5,300 – 1,475	50.12%	1,375 – 150	53.90%	300 – 100	42.97%
160 <= SPL <170	15,825 – 6,188	16.38%	1,475 – 150	17.63%	150 – <50	2.44%	100 – <50	17.06%
170 <= SPL <180	6,188 – 1,888	4.46%	150 – <50	0.27%	<50	0.00%	<50	0.00%
180 <= SPL <190	1,888 – 250	0.51%	<50	0.00%	<50	0.00%	<50	0.00%
190 <= SPL <200	250 – <50	0.01%	<50	0.00%	<50	0.00%	<50	0.00%

ASW: anti-submarine warfare; dB: decibel; m: meter; MIW: mine warfare; SPL: sound pressure level; <: less than; %: percent

Table 3.4-12: Range to 10-dB Bins and Percentage of Behavioral Harassments in Each Bin for Mid-Frequency Cetaceans under the Odontocete Behavioral Risk Function for Four Representative Sonar Systems

Received Level in 10-dB Bins	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., SQQ-32; MIW Sonar)	
	Distance Over Which Levels Occur (m)	Percentage of Behavioral Harassments Occurring at Given Levels	Distance Over Which Levels Occur (m)	Percentage of Behavioral Harassments Occurring at Given Levels	Distance Over Which Levels Occur (m)	Percentage of Behavioral Harassments Occurring at Given Levels	Distance Over Which Levels Occur (m)	Percentage of Behavioral Harassments Occurring at Given Levels
120 <= SPL <130	179,525 – 139,300	0.00%	61,433 – 22,208	0.00%	20,638 – 11,917	0.00%	4,388 – 3,375	0.00%
130 <= SPL <140	139,300 – 78,263	0.05%	22,208 – 15,563	0.11%	11,917 – 4,913	0.68%	3,375 – 1,913	0.09%
140 <= SPL <150	78,263 – 66,525	1.02%	15,563 – 5,425	15.91%	4,913 – 1,738	19.95%	1,913 – 1,013	4.78%
150 <= SPL <160	66,525 – 16,338	66.88%	5,425 – 1,475	54.68%	1,738 – 150	75.99%	1,013 – 400	42.12%
160 <= SPL <170	16,338 – 6,388	24.26%	1,475 – 150	28.82%	150 – <50	3.38%	400 – 100	48.72%
170 <= SPL <180	6,388 – 1,888	7.04%	150 – <50	0.47%	<50	0.00%	100 – <50	4.29%
180 <= SPL <190	1,888 – 250	0.73%	<50	0.00%	<50	0.00%	<50	0.00%
190 <= SPL <200	250 – <50	0.01%	<50	0.00%	<50	0.00%	<50	0.00%

ASW: anti-submarine warfare; dB: decibel; m: meter; MIW: mine warfare; SPL: sound pressure level; <: less than; %: percent

Note: Odontocete Behavioral Risk Function is also used for high-frequency cetaceans, phocid seals, and manatees

Table 3.4-13: Activities Using Sonar and Other Active Acoustic Sources Preceded by Multiple Vessel Movements or Hovering Helicopters

ACTIVITY
Training
Airborne Mine Countermeasure – Mine Detection
Civilian Port Defense
Composite Training Unit Exercise
Group Sail
Integrated Anti-Submarine Warfare Course
Joint Task Force Exercise/Sustainment Exercise
Kilo Dip
Mine Countermeasures Exercise – Ship Sonar
Tactical Development Exercise
Tracking Exercise/Torpedo Exercise – Helo
Testing
Airborne Mine Hunting Test
Anti-Submarine Warfare Mission Package Testing
Anti-Submarine Warfare Tracking Test – Helo
Countermeasure Testing[1]
Mine Countermeasure Mission Package Testing
Mine Countermeasure/Neutralization Testing
Mine Detection/Classification Testing
Naval Surface Warfare Center: Mine Detection and Classification Testing
Naval Surface Warfare Center: Stationary Source Testing
Naval Surface Warfare Center: Unmanned Underwater Vehicle Demonstration
Naval Surface Warfare Center: Unmanned Underwater Vehicle Testing
Naval Undersea Warfare Center: Towed Equipment Testing
Naval Undersea Warfare Center: Unmanned Underwater Vehicle Demonstration
Naval Undersea Warfare Center: Unmanned Underwater Vehicle Testing
South Florida Ocean Measurement Facility: Surface Testing Activities
South Florida Ocean Measurement Facility: Unmanned Underwater Vehicle Demonstration
Sonobuoy Lot Acceptance Testing
Torpedo (Explosive) Testing
Torpedo (Non-Explosive) Testing

[1]A score of 0.5 was applied for this activity.

The Navy Acoustic Effects Model does not consider mitigation, discussed in detail in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). As explained in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), to account for the implementation of mitigation measures, the acoustic effects analysis assumes a model-estimated PTS would not occur if an animal at the water surface would likely be observed during those activities with dedicated Lookouts up to and during use of the sound source, considering the mitigation effectiveness (see Table 3.4-14) and sightability of a species based on g(0) (see Table 5.3-1). The range to PTS is generally less than 50 m (55 yd.), and the largest single ping range to PTS for the most powerful sonar system is approximately 100 m (109 yd.), so Lookouts need only to detect animals before they are within a very close range of a sound source to prevent PTS. The model-estimated PTS values are reduced by the portion of animals that are likely to be seen (Mitigation Effectiveness x Sightability); these animals are instead assumed to be present within the range to TTS. A detailed explanation of this analysis is provided in the technical report *Post-Model Quantitiative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for Atlantic Fleet Training and Testing* (U.S. Department of the Navy 2013b).

Table 3.4-14: Consideration of Mitigation in Acoustic Effects Analysis for Sonar and Other Active Acoustic Sources

Activity[1]	Mitigation Effectiveness Factor for Acoustic Analysis	Mitigation Platform[2]
Training		
Airborne Mine Countermeasure – Mine Detection	1	Aircraft
Civilian Port Defense	1	Vessel
Composite Unit Training Exercise	1	Vessel
Integrated Anti-Submarine Warfare Course	1	Vessel
Joint Task Force Exercise/Sustainment Exercise	1	Vessel
Group Sail	1	Vessel
Mine Countermeasures Exercise – Ship Sonar	1	Vessel
Mine Neutralization – Remotely Operated Vehicle	1	Vessel
Tactical Development Exercise	1	Vessel
Submarine Sonar Maintenance	0.5	Vessel
Surface Ship Object Detection	1	Vessel
Surface Ship Sonar Maintenance	1	Vessel
Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft Sonobuoy	0.5	Aircraft
Tracking Exercise/Torpedo Exercise – Surface	0.5	Vessel
Tracking Exercise/Torpedo Exercise – Helo	0.5	Aircraft
Testing		
Airborne Mine Hunting Test	1	Aircraft
Anti-Submarine Warfare Tracking Test – Helo	1	Aircraft
Anti-Submarine Warfare Mission Package Testing	0.5	Aircraft
At-Sea Sonar Testing	0.5	Vessel
Combat System Ship Qualification Trials: In-Port	1	Vessel
Combat System Ship Qualification Trials: Undersea Warfare	0.5	Vessel
Countermeasure Testing	0.5	Vessel
Kilo Dip	1	Aircraft
Mine Countermeasure/Neutralization Testing	1	Vessel
Mine Detection/Classification Testing	1	Vessel
Naval Surface Warfare Center: Mine Detection and Classification Testing	1	Vessel
Naval Surface Warfare Center: Stationary Source Testing	1	Vessel
Naval Undersea Warfare Center: Pierside Integrated Swimmer Defense	1	Vessel
Naval Undersea Warfare Center: Semi-Stationary Equipment Testing	1	Vessel
Naval Undersea Warfare Center: Towed Equipment Testing	1	Vessel
Pierside Integrated Swimmer Defense	1	Vessel
Pierside Sonar Testing	1	Vessel
South Florida Ocean Measurement Facility: Surface Testing Activities	1	Vessel
Sonobuoy Lot Acceptance Testing	1	Vessel
Submarine Sonar Testing/Maintenance	0.5	Vessel
Surface Combatant Sea Trials: Anti-Submarine Warfare Testing	1	Vessel
Surface Combatant Sea Trials: Pierside Sonar Testing	1	Vessel
Surface Ship Sonar Testing/Maintenance	1	Vessel
Torpedo (Non-Explosive) Testing	0.5	Vessel

[1] If less than half of the mitigation zone can be continuously visually observed or if the mitigation zone cannot be continuously visually observed during most of the scenarios within the activity due to the type of surveillance platform(s), number of Lookouts, and size of the mitigation zone, mitigation is not considered in the acoustic effects analysis of that activity and the activity is not listed in this table.
[2] The activity is scored based on the ability of the individual platform to implement the mitigation.

Animal avoidance of the area immediately around the sonar or other active acoustic system, coupled with mitigation measures designed to avoid exposing animals to high energy levels, would make the majority of model-estimated PTS exposures of mid-frequency cetaceans unlikely. The maximum ranges to the onset of PTS are discussed in Section 3.4.3.1.8.1 (Range to Effects) above and shown in Table 3.4-9. The range to PTS for mid-frequency cetaceans (Table 3.4-9) does not exceed 50 m (55 yd.) in any environment or for any sonar or other active acoustic source. In fact, the single ping range to PTS for mid-frequency cetaceans due to the AN/SQS-53 is 10 m, and the PTS range for five pings is about 20 m. The most powerful source, the AN/SQS-53, can span as much as 270 degrees; however, an animal would need to maintain a position within a 20 m radius in front of or along the bow of the ship for over 3 minutes (given the time between five pings) to experience PTS. Additionally, odontocetes have demonstrated directional hearing, with best hearing sensitivity facing a sound source (Kastelein et al. 2005a; Mooney et al. 2008; Popov and Supin 2009). An odontocete avoiding a source would receive sounds along a less sensitive hearing axis, potentially reducing impacts. All model-estimated PTS exposures of mid-frequency cetaceans, therefore, are considered to actually be TTS due to the likelihood that an animal would be observed if it is present within the very short range to PTS effects.

Marine mammals in other functional hearing groups (i.e., low-frequency and high-frequency cetaceans; phocid seals; and manatees), if present but not observed by Lookouts, are assumed to leave the area near the sound source after the first few pings, thereby reducing sound exposure levels and the potential for PTS. Based on nominal marine mammal swim speeds and normal operating parameters for Navy vessels, it was determined that an animal can easily avoid PTS zones within the timeframe it takes an active sound source to generate one to two pings. As a conservative measure, and to account for activities where there may be a pause in sound transmission, PTS was accounted for over three to four pings of an activity. Additionally, as stated above, during avoidance behaviors, sound exposure of odontocetes (including high-frequency cetaceans) may be minimized due to directional hearing. During the first few pings of an event, or after a pause in sonar activities, if animals are caught unaware and it was not possible to implement mitigation measures (e.g., animals are at depth and not visible at the surface) it is possible they could receive enough acoustic energy to suffer PTS. Only these initial exposures, at the beginning of the activity or after a pause in sound transmission, are expected to actually occur. The remaining model-estimated PTS exposures are considered to actually be TTS exposures due to avoidance.

3.4.3.1.8.3 Predicted Impacts from Sonar and Other Active Acoustic Sources

Table 3.4-15 through Table 3.4-18 present the predicted impacts on marine mammals separated between training and testing activities, and between annual and nonannual events. Nonannual events, those events that may only take place a few times over the five-year period and do not reoccur every year, are considered separately because these impacts would not be assessed each year. These predicted effects are the result of the acoustic analysis, including acoustic effects modeling followed by consideration of animal avoidance of multiple exposures, avoidance by sensitive species of areas with a high level of activity, and Navy mitigation measures.

It is important to note that acoustic impacts presented in Table 3.4-15 through Table 3.4-18 are the total number of impacts and not necessarily the number of individuals impacted. As discussed in Section 3.4.3.1.5.3 (Navy Acoustic Effects Model), an animal could be predicted to receive more than one acoustic impact over the course of a year.

Table 3.4-15: Predicted Impacts per Year from Annually Recurring Sonar and Other Active Acoustic Training Activities

	No Action Alternative			Alternatives 1 & 2		
	Behavioral Reaction	TTS	PTS	Behavioral Reaction	TTS	PTS
Mysticetes						
Blue Whale*	26	31	0	50	97	0
Bryde's Whale	181	217	0	326	629	0
Minke Whale	11,770	16,175	2	19,497	40,866	10
Fin Whale*	879	972	0	1,608	2,880	1
Humpback Whale*	320	402	0	514	1,128	1
North Atlantic Right Whale*	33	22	0	51	60	0
Sei Whale*	1,954	2,112	0	3,582	6,604	1
Odontocetes – Delphinids						
Atlantic Spotted Dolphin	76,776	4,746	0	161,590	15,781	0
Atlantic White-Sided Dolphin	16,820	427	0	30,014	1,183	0
Bottlenose Dolphin	131,994	7,844	0	260,189	24,116	0
Clymene Dolphin	8,222	459	0	17,929	1,655	0
Common Dolphin	206,604	9,725	0	429,199	35,731	0
False Killer Whale	280	15	0	653	60	0
Fraser's Dolphin	1,027	42	0	2,044	161	0
Killer Whale	6,269	286	0	12,984	1,069	0
Melon-Headed Whale	9,774	458	0	19,216	1,659	0
Pantropical Spotted Dolphin	25,744	1,701	0	64,668	6,291	0
Pilot Whale	46,324	1,931	0	94,552	6,672	0
Pygmy Killer Whale	702	34	0	1,364	123	0
Risso's Dolphin	104,045	4,762	0	220,716	17,779	0
Rough-Toothed Dolphin	465	26	0	964	94	0
Spinner Dolphin	7,668	508	0	18,396	2,015	0
Striped Dolphin	100,475	4,621	0	206,688	17,593	0
White-Beaked Dolphin	1,112	31	0	1,547	44	0
Odontocetes – Sperm Whales						
Sperm Whale*	6,623	92	0	14,311	435	0
Odontocetes – Beaked Whales						
Blainville's Beaked Whale	13,627	46	0	27,991	187	0
Cuvier's Beaked Whale	17,256	51	0	34,698	196	0
Gervais' Beaked Whale	14,063	65	0	28,020	233	0
Northern Bottlenose Whale	10,806	12	0	18,320	36	0
Sowerby's Beaked Whale	4,710	15	0	9,907	56	0
True's Beaked Whale	7,444	15	0	16,637	73	0
Odontocetes – *Kogia* Species and Porpoises						
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	104	1,995	5	169	4,914	13
Harbor Porpoise	117,605	18,955	57	120,895	20,161	62
Phocid Seals						
Bearded Seal	0	0	0	0	0	0
Gray Seal	29	0	0	35	0	0
Harbor Seal	30	0	0	37	0	0
Harp Seal	0	0	0	0	0	0
Hooded Seal	4	0	0	5	0	0
Ringed Seal*	0	0	0	0	0	0
Manatees						
West Indian Manatee*	9	0	0	9	0	0

PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA-listed species

Table 3.4-16: Predicted Impacts per Year from Annually Recurring Sonar and Other Active Acoustic Testing Activities

	No Action Alternative			Alternative 1			Alternative 2		
	Behavioral Reaction	TTS	PTS	Behavioral Reaction	TTS	PTS	Behavioral Reaction	TTS	PTS
Mysticetes									
Blue Whale*	1	1	0	5	9	0	6	10	0
Bryde's Whale	2	1	0	19	37	0	21	39	0
Minke Whale	400	337	0	2,733	3,323	1	3,100	3,571	1
Fin Whale*	38	21	0	253	250	0	282	263	0
Humpback Whale*	12	10	0	87	89	0	100	94	0
North Atlantic Right Whale*	2	2	0	54	9	0	66	11	0
Sei Whale*	37	21	0	288	419	0	316	439	0
Odontocetes – Delphinids									
Atlantic Spotted Dolphin	2,036	513	0	11,242	6,674	0	12,562	7,447	0
Atlantic White-Sided Dolphin	1,006	60	0	6,925	2,114	0	7,776	2,164	0
Bottlenose Dolphin	2,829	831	0	14,619	10,549	0	16,488	11,760	0
Clymene Dolphin	242	48	0	1,149	649	0	1,302	695	0
Common Dolphin	3,960	769	0	25,568	15,549	0	28,764	16,913	0
False Killer Whale	13	3	0	52	35	0	60	37	0
Fraser's Dolphin	7	2	0	90	53	0	98	57	0
Killer Whale	118	22	0	823	452	0	921	486	0
Melon-Headed Whale	76	12	0	700	558	0	767	590	0
Pantropical Spotted Dolphin	780	83	0	3,474	3,569	0	3,916	3,679	0
Pilot Whale	1,280	160	0	9,221	4,126	0	10,343	4,370	0
Pygmy Killer Whale	6	1	0	62	47	0	67	50	0
Risso's Dolphin	2,063	359	0	13,135	7,034	0	14,693	7,614	0
Rough-Toothed Dolphin	10	2	0	64	46	0	70	50	0

PTS: permanent threshold shift; TTS: temporary threshold shift

* ESA-listed species

Table 3.4-16: Predicted Impacts per Year from Annually Recurring Sonar and Other Active Acoustic Testing Activities (Continued)

	No Action Alternative			Alternative 1			Alternative 2		
	Behavioral Reaction	TTS	PTS	Behavioral Reaction	TTS	PTS	Behavioral Reaction	TTS	PTS
Spinner Dolphin	488	57	0	1,575	723	0	1,799	786	0
Striped Dolphin	1,358	163	0	11,112	6,430	0	12,208	6,784	0
White-Beaked Dolphin	144	32	0	1,164	292	0	1,335	302	0
Odontocetes – Sperm Whale									
Sperm Whale*	110	10	0	1,010	564	0	1,101	584	0
Odontocetes – Beaked Whales									
Blainville's Beaked Whale	792	2	0	4,167	102	0	4,595	107	0
Cuvier's Beaked Whale	1,045	3	0	5,362	133	0	5,943	139	0
Gervais' Beaked Whale	773	6	0	4,096	120	0	4,526	130	0
Northern Bottlenose Whale	2,762	2	0	10,184	130	0	11,946	132	0
Sowerby's Beaked Whale	513	2	0	2,266	41	0	2,617	43	0
True's Beaked Whale	523	1	0	2,762	40	0	3,068	41	0
Odontocetes – *Kogia* Species and Porpoises									
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	7	66	0	25	954	5	29	1061	5
Harbor Porpoise	692,605	23,948	5	1,130,312	70,605	98	1,964,774	78,250	99
Phocid Seals									
Bearded Seal	1	1	0	25	1	0	31	1	0
Gray Seal	71	469	5	1,529	737	6	1,874	828	7
Harbor Seal	197	3,317	38	1,461	5,315	55	1,703	5,833	62
Harp Seal	157	240	0	1,902	739	4	2,275	791	4
Hooded Seal	20	4	0	214	34	0	251	35	0
Ringed Seal*	9	1	0	288	3	0	355	4	0
Manatees									
West Indian Manatee*	0	0	0	0	0	0	0	0	0

PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA-listed species

Table 3.4-17: Predicted Impacts per Event for Sonar and Other Active Acoustic Sources Used in the Biennial Training Activity, Civilian Port Defense – Proposed under Alternatives 1 and 2 Only

	Alternatives 1 & 2[1]		
	Behavioral Reaction	TTS	PTS
Mysticetes			
Bryde's Whale	0	0	0
Minke Whale	0	0	0
Fin Whale*	0	0	0
Humpback Whale*	0	0	0
North Atlantic Right Whale*	0	0	0
Sei Whale*	0	0	0
Bryde's Whale*	0	0	0
Odontocetes – Delphinids			
Atlantic Spotted Dolphin	149	1	0
Atlantic White-Sided Dolphin	20	0	0
Bottlenose Dolphin	345	6	0
Clymene Dolphin	1	0	0
Common Dolphin	24	0	0
False Killer Whale	0	0	0
Fraser's Dolphin	0	0	0
Killer Whale	1	0	0
Melon-Headed Whale	0	0	0
Pantropical Spotted Dolphin	3	0	0
Pilot Whale	10	0	0
Pygmy Killer Whale	0	0	0
Risso's Dolphin	11	0	0
Rough-Toothed Dolphin	1	0	0
Spinner Dolphin	1	0	0
Striped Dolphin	7	0	0
White-Beaked Dolphin	19	0	0
Odontocetes – Sperm Whale			
Sperm Whale*	1	0	0
Odontocetes – Beaked Whales			
Blainville's Beaked Whale	1	0	0
Cuvier's Beaked Whale	1	0	0
Gervais' Beaked Whale	2	0	0
Northern Bottlenose Whale	2	0	0
Sowerby's Beaked Whale	1	0	0
True's Beaked Whale	1	0	0
Odontocetes – *Kogia* Species and Porpoises			
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	0	1	0
Harbor Porpoise	725	432	0
Phocid Seals			
Gray Seal	47	0	0
Harbor Seal	43	0	0
Harp Seal	4	0	0
Hooded Seal	0	0	0
Manatees			
West Indian Manatee*	0	0	0

PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA-listed species
[1] Civilian port defense does not occur under the No Action Alternative.

Table 3.4-18: Predicted Impacts for Nonannual Sonar and Other Active Acoustic Source Testing Activities Involving Unmanned Underwater Vehicle Demonstrations Occurring Once per Five-Year Period at Each Location: Naval Surface Warfare Center, Panama City Division; South Florida Ocean Measurement Facility near Fort Lauderdale, Florida; and Naval Undersea Warfare Center Division, Newport near Newport, Rhode Island

	NSWC PCD (All Alternatives)			SFOMF (Alternatives 1 and 2 Only)			NUWCDIVNPT (All Alternatives)		
	Behavioral Reaction	TTS	PTS	Behavioral Reaction	TTS	PTS	Behavioral Reaction	TTS	PTS
Mysticetes									
Blue Whale*	0	1	0	0	1	0	0	0	0
Bryde's Whale	0	1	0	0	3	0	0	0	0
Minke Whale	23	469	1	3	342	0	6	191	1
Fin Whale*	2	30	0	0	2	0	0	14	0
Humpback Whale*	0	2	0	0	2	0	0	1	0
North Atlantic Right Whale*	0	0	0	0	0	0	0	10	0
Sei Whale*	1	14	0	0	18	0	0	1	0
Odontocetes – Delphinids									
Atlantic Spotted Dolphin	52	1,753	0	7	1,168	0	5	190	0
Atlantic White-Sided Dolphin	2	38	0	0	0	0	7	190	0
Bottlenose Dolphin	87	2,731	0	14	1,926	0	13	419	0
Clymene Dolphin	7	157	0	0	10	0	0	0	0
Common Dolphin	74	2,362	0	13	2,622	0	6	145	0
False Killer Whale	0	9	0	0	3	0	0	0	0
Fraser's Dolphin	0	6	0	0	9	0	0	0	0
Killer Whale	2	61	0	1	59	0	0	5	0
Melon-Headed Whale	2	51	0	0	73	0	0	0	0
Pantropical Spotted Dolphin	21	261	0	1	55	0	0	0	0
Pilot Whale	12	351	0	3	385	0	6	120	0
Pygmy Killer Whale	0	4	0	0	11	0	0	0	0
Risso's Dolphin	36	1,111	0	6	723	0	2	77	0
Rough-Toothed Dolphin	0	6	0	0	11	0	0	0	0

NSWC PCD: Naval Undersea Warfare Center, Panama City Division Testing Range; NUWCDIV NPT: Naval Undersea Warfare Center Division, Newport Testing Range; PTS: permanent threshold shift; SFOMF: South Florida Ocean Measurement Facility Testing Range; TTS: temporary threshold shift

Table 3.4-18: Model-Predicted Impacts for Nonannual Sonar and other Active Acoustic Source Testing Activities Involving Unmanned Underwater Vehicle Demonstrations Occurring Once per Five-Year Period at Each Location: Naval Surface Warfare Center, Panama City Division; South Florida Ocean Measurement Facility near Fort Lauderdale, Florida; and Naval Undersea Warfare Center Division, Newport near Newport, Rhode Island (Continued)

	NSWC PCD (All Alternatives)			SFOMF (Alternatives 1 and 2 Only)[1]			NUWCDIVNPT (All Alternatives)		
	Behavioral Reaction	TTS	PTS	Behavioral Reaction	TTS	PTS	Behavioral Reaction	TTS	PTS
Spinner Dolphin	17	169	0	1	70	0	0	0	0
Striped Dolphin	20	443	0	4	604	0	1	22	0
White-Beaked Dolphin	0	0	0	0	0	0	9	171	0
Odontocetes – Sperm Whale									
Sperm Whale*	1	27	0	0	52	0	0	3	0
Odontocetes – Beaked Whales									
Blainville's Beaked Whale	10	7	0	16	12	0	3	2	0
Cuvier's Beaked Whale	13	8	0	27	11	0	1	2	0
Gervais' Beaked Whale	29	18	0	36	22	0	1	1	0
Northern Bottlenose Whale	1	1	0	0	0	0	6	6	0
Sowerby's Beaked Whale	21	10	0	0	0	0	4	3	0
True's Beaked Whale	13	5	0	0	0	0	4	2	0
Odontocetes – *Kogia* Species and Porpoises									
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	0	48	1	0	17	1	0	0	0
Harbor Porpoise	0	0	0	0	0	0	121,689	17,326	0
Phocid Seals									
Bearded Seal	0	0	0	0	0	0	0	1	0
Gray Seal	0	0	0	0	0	0	22	557	6
Harbor Seal	0	0	0	0	0	0	37	1,083	15
Harp Seal	0	0	0	0	0	0	36	891	10
Hooded Seal	0	0	0	0	0	0	0	7	0
Ringed Seal*	0	0	0	0	0	0	0	0	0

NSWC PCD: Naval Undersea Warfare Center, Panama City Division Testing Range; NUWCDIV NPT: Naval Undersea Warfare Center Division, Newport Testing Range; PTS: permanent threshold shift; SFOMF: South Florida Ocean Measurement Facility Testing Range; TTS: temporary threshold shift

Note: NA: Species not analyzed for specific area because they do not occur there.

* ESA-listed species

[1] Unmanned Underwater Vehicle Demonstrations would not occur at South Florida Ocean Measurement Facility Testing Range under the No Action Alternative.

3.4.3.1.8.4 No Action Alternative – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources), training activities under the No Action Alternative include activities that produce in-water noise from the use of sonar and other active acoustic sources. Activities could occur throughout the Study Area but would be concentrated in VACAPES, Navy Cherry Point, and Jacksonville (JAX) Range Complexes, with fewer events in the Gulf of Mexico (GOMEX) and Northeast Range Complexes. These Navy range complexes are within the Northeast and Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems and the Gulf Stream Open Ocean Area.

Predicted acoustic impacts on marine mammals from exposure to sonar and other active acoustic sources for annually recurring training activities under the No Action Alternative are shown in Table 3.4-15. Civilian Port Defense would not occur under the No Action Alternative; therefore, all sonar and other active acoustic source training activities under the No Action Alternative potentially reoccur each year.

Mysticetes

Predicted impacts on mysticetes from training activities under the No Action Alterative from sonar and other active acoustic sources are primarily (approximately 88 percent) from anti-submarine warfare activities. Remaining predicted effects to mysticetes from this stressor are from surface ship and submarine sonar maintenance and navigation. As discussed in Section 3.4.3.1.8.1 (Range to Effects), ranges to TTS for hull-mounted sonar (e.g., sonar bin MF1: SQS-53 anti-submarine warfare hull-mounted sonar) can be on the order of several kilometers, whereas some behavioral effects could take place at distances exceeding 100 km. Significant behavioral effects, however, are much more likely at higher received levels within a few kilometers of the sound source.

Approximately 68 percent of the predicted acoustic impacts on mysticetes from training activities using sonar and other active acoustic sources under the No Action Alternative are predicted within the JAX Range Complex, followed by the Navy Cherry Point, VACAPES, Northeast, and GOMEX Range Complexes.

Under the No Action Alternative, about 23 percent of predicted acoustic impacts on mysticetes from sonar and other active acoustic sources are due to the major training exercises (composite training unit exercise and joint task force/sustainment exercise). These major training exercises are multi-day events that transition across large areas and involve multiple anti-submarine warfare assets. These events take place in the VACAPES, Navy Cherry Point, and JAX Range Complexes, and one composite training unit exercise per year could take place within the GOMEX Range Complex. Within the JAX Range Complex, sonar activities could be concentrated on the Undersea Warfare Training Range after it is constructed. Potential acoustic impacts from major training exercises, especially behavioral impacts, could be more pronounced given the duration and scale of the events. Some animals may be exposed multiple times over the course of a few days. Many mysticetes may stop vocalizing, break off feeding dives, or ignore the acoustic stimulus, especially if it is more than a few kilometers away. Section 3.4.3.1.2.5 (Behavioral Reactions) discusses research and observations on the behavioral reactions of mysticetes to sonar and other active acoustic sources. Migrating mysticetes may divert around sound sources that are within their path. More sensitive mysticetes may avoid a major training exercise as it moves through an area, although these activities 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 moves away, allowing the animal to recover from any energy expenditure or missed resources. It is unlikely that most mysticetes would encounter a major training exercise more than once per year.

Training activities involving the coordination of multiple assets, including Group Sail, anti-submarine warfare tactical development exercise, and integrated anti-submarine warfare course, are responsible for approximately 25 percent of the predicted impacts on mysticetes. Although smaller in scale and shorter in duration than major training exercises discussed above, these events can still last for a matter of days and transit across large areas of a range complex. The majority of these events take place within the JAX Range Complex, followed by the Navy Cherry Point and VACAPES Range Complexes; however, the integrated anti-submarine warfare course could also take place in the GOMEX Range Complex once per year. Repeated exposures to some individual whales are likely in these events; however, due to the shorter duration and smaller footprint as compared to major training exercises, impacts from these activities are likely to be less pronounced.

Unit level training activities, including anti-submarine warfare, navigation, and object detection activities, are responsible for approximately 42 percent of the total impacts on mysticetes. These events could take place anywhere within the Study Area, but are concentrated within the VACAPES, Navy Cherry Point, and JAX Range Complexes, with fewer events taking place within the Northeast and GOMEX Range Complexes. These events often involve the use of a single vessel, perhaps participating with an aircraft, but overall activity is limited and lasts for only a few hours over a small area of ocean. Given the short duration of these activities, they often occur close to homeports and in the same general locations each time. These conditions could result in resident animals more frequently being exposed to these types of activities. Submarine and surface ship sonar maintenance is responsible for about 10 percent of the total predicted acoustic impacts on mysticetes from sonar and other active acoustic sources; however, maintenance activities always involve the use of a single system in a limited manner either pierside or in the open ocean. These training and maintenance activities are limited in scope and duration, so significant behavioral reactions are not expected in most cases.

All other activities, including submarine under ice certification and mine hunting (mine countermeasures–ship sonar and airborne mine countermeasure–mine detection) use high-frequency systems that are not within mysticetes' ideal hearing range; therefore, there were no predicted effects. Section 3.4.2.3 (Vocalization and Hearing of Marine Mammals) discusses low-frequency cetacean (i.e., mysticetes) hearing abilities. It is unlikely that any of the acoustic stressors within these activities would cause a significant behavioral reaction by a mysticete.

North Atlantic Right Whales (ESA-Listed)

North Atlantic right whales may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. Exposures could occur in feeding grounds off the New England coast, on migration routes along the east coast, and on calving grounds in the southeast off the coast of Florida and Georgia. The acoustic analysis predicts that North Atlantic right whales could be exposed to sound that may result in 22 TTS and 33 behavioral reactions per year. The majority of these impacts are predicted in the JAX Range Complex, where animals spend winter months calving. All predicted impacts would be to the Gulf of Maine stock because this is the only North Atlantic right whale stock present within the Study Area.

Research and observations show that if mysticetes are exposed to sonar or other active acoustic sources 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). Reactions may include alerting; breaking off feeding dives and surfacing; diving or swimming away; or no response at all. Additionally, migrating animals may ignore a sound source or may divert around the source if it is in their path. In the ocean, the use of sonar and other active acoustic sources is transient and is unlikely to repeatedly expose the same population of animals over a short period. Around heavily trafficked Navy ports and on fixed ranges, the possibility is greater for animals that are resident during all or part of the year to be exposed multiple times to sonar and other active acoustic sources. A few behavioral reactions per year, even by a single individual, are unlikely to produce long-term consequences for that individual or the population.

Animals that do experience TTS may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations until their hearing recovers. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. Considering these factors and the low number of overall predicted impacts, long-term consequences for individuals or populations would not be expected.

In the southeast North Atlantic right whale mitigation area (as discussed in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring), no training activities using sonar or other active acoustic sources would occur under any alternative with the exception of object detection/navigational sonar training and maintenance activities for surface ships and submarines while entering or exiting ports located in Kings Bay, Georgia, and Mayport, Florida. In addition, training activities involving helicopter dipping sonar would occur off of Mayport, Florida, within the right whale critical habitat. As stated in Section 3.4.2.5 (North Atlantic Right Whale [*Eubalaena glacialis*]), the most concentrated densities of North Atlantic right whales are within the migratory corridor, which includes the southeastern North Atlantic right whale critical habitat at its southern extent. However, the majority of active sonar activities would occur outside the southeast critical habitat. North Atlantic right whales can be found outside designated critical habitat, and sound from nearby activities may be detectable within the critical habitat. Acoustic modeling predictions consider these potential circumstances.

As discussed in detail in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring), before transiting through or conducting any training or testing activities within the southeast North Atlantic right whale mitigation area during calving season (15 November to 15 April), the Navy will initiate communication with the Fleet Area Control and Surveillance Facility, Jacksonville to obtain Early Warning System North Atlantic right whale sightings data. When transiting within the mitigation area, all Navy vessels will exercise extreme caution and proceed at the slowest speed that is consistent with safety, mission, training, and operations. This high level of awareness will further enhance the Navy's mitigation effectiveness for reducing potential acoustic impacts to North Atlantic right whales.

In the northeast North Atlantic right whale mitigation area (see Chapter 5 [Standard Operating Procedures, Mitigation, and Monitoring] for a description of the area), hull-mounted sonar would not be used during training or testing. However, a limited number of torpedo exercises would be conducted in August and September, when many North Atlantic right whales have migrated south out of the area. These torpedo exercise areas were established during previous ESA consultations with NMFS. Under all alternatives, torpedo exercise activities would not occur within 2.7 nm of the Stellwagen Bank National Marine Sanctuary.

The sound from sonar and other active acoustic sources associated with training activities under the No Action Alternative would not impact the assumed primary constituent elements of the North Atlantic right whale critical habitat (i.e., water temperature and depth in the southeast and copepods in the northeast).

Humpback Whales (ESA-Listed)

Humpback whales may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that humpback whales could be exposed to sound that may result in 402 TTS and 320 behavioral reactions per year. The majority of these impacts are predicted in the VACAPES, Navy Cherry Point, and JAX Range Complexes. All predicted impacts would be to the Gulf of Maine stock since this is the only humpback whale stock present within the Study Area. The costs and potential long-term consequences to the individuals resulting from predicted TTS and behavioral reactions would be similar to those described above for the North Atlantic right whale. Long-term consequences for populations are not expected.

Sei Whales (ESA-Listed)

Sei whales may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that sei whales could be exposed to sound that may result in 2,112 TTS and 1,954 behavioral reactions per year. The majority of these impacts are predicted in the VACAPES, Navy Cherry Point, and JAX Range Complexes, with a relatively small percent predicted in the GOMEX and Northeast Range Complexes. All predicted impacts would be to the Nova Scotia stock since this is the only sei whale stock present within the Study Area. The costs and potential long-term consequences to the individuals resulting from predicted TTS and behavioral reactions would be similar to those described above for the North Atlantic right whale. Long-term consequences for populations are not expected.

Fin Whales (ESA-Listed)

Fin whales may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that fin whales could be exposed to sound that may result in 972 TTS and 879 behavioral reactions per year. The majority of these impacts are predicted in the VACAPES, Navy Cherry Point, and JAX Range Complexes, with a relatively small percent of impacts predicted in the GOMEX and Northeast Range Complexes. All predicted impacts would be to the Western North Atlantic stock since this is the only fin whale stock present within the Study Area. The costs and potential long-term consequences to the individuals resulting from predicted TTS and behavioral reactions would be similar to those described above for the North Atlantic right whale. Long-term consequences for populations are not expected.

Blue Whales (ESA-Listed)

Blue whales may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that blue whales could be exposed to sound that may result in 31 TTS and 26 behavioral reactions per year. The majority of these impacts are predicted in the VACAPES, Navy Cherry Point, and JAX Range Complexes, with a relatively small percent of impacts predicted in the GOMEX and Northeast Range Complexes. All predicted impacts would be to the Western North Atlantic stock since this is the only blue whale stock present within the Study Area. The costs and potential long-term consequences to the individuals resulting from predicted TTS and behavioral reactions would be similar to those described above for the North Atlantic right whale. Long-term consequences for populations are not expected.

Minke and Bryde's Whales

Minke and Bryde's whales may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that Bryde's whales could be exposed to sound that may result in 217 TTS and 181 behavioral reactions. The acoustic analysis predicts that minke whales could be exposed to sound that may result in 2 PTS; 16,175 TTS; and

11,770 behavioral reactions per year. For both species, the majority of these impacts are predicted in the VACAPES, Navy Cherry Point, and JAX Range Complexes, with a relatively small percent of impacts predicted in the Northeast Range Complexes. Minke whales also have a relatively small number of impacts predicted in the GOMEX Range Complex. All predicted impacts on minke whales would be to the Canadian East Coast stock and all predicted impacts on Bryde's whales would be to the Gulf of Mexico Oceanic stock since these are the only stocks for these species present within the Study Area.

The costs and potential long-term consequences to the individuals resulting from predicted TTS and behavioral reactions would be similar to those described above for the North Atlantic right whale. Long-term consequences for populations are not expected. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age. Long-term consequences for minke whale populations, which number in the thousands, are not expected.

Odontocetes

Predicted impacts on odontocetes from training activities under the No Action Alterative from sonar and other active acoustic sources are about 75 percent from anti-submarine warfare activities; about 15 percent from surface ship object detection and submarine navigational exercises; about 9 percent for submarine and surface ship sonar maintenance; and about one percent from mine neutralization and countermeasure exercises. As discussed in Section 3.4.3.1.8.1 (Range to Effects), ranges to TTS for hull-mounted sonar (e.g., sonar bin MF1; SQS-53 anti-submarine warfare hull-mounted sonar) can be on the order of a few hundred meters for mid-frequency odontocetes (cetaceans) but can stretch to distances of over 10 km for high-frequency cetaceans (i.e., harbor porpoises and dwarf and pygmy sperm whales). Some behavioral impacts could take place at distances exceeding 100 km, especially for more sensitive species such as harbor porpoises and beaked whales, although significant behavioral effects are much more likely at higher received levels within a few kilometers of the sound source.

The majority of acoustic impacts on odontocetes from training activities using sonar and other active acoustic sources under the No Action Alternative are predicted within the JAX Range Complex (approximately 57 percent), followed by the VACAPES (approximately 25 percent) and Navy Cherry Point (approximately 10 percent) Range Complexes. The approximately 8 percent of impacts remaining were predicted within the GOMEX and the Northeast Range Complexes.

About 20 percent of predicted acoustic impacts on odontocetes from sonar and other active acoustic sources are due to composite training unit exercise and joint task force/sustainment exercise. These major training exercises are multiday events that transition large areas and involve multiple anti-submarine warfare assets as described above under Mysticetes. More sensitive species of odontocetes such as beaked whales, harbor porpoises, and dwarf and pygmy sperm whales may avoid the area for the duration of the event. Section 3.4.3.1.2.5 (Behavioral Reactions) discusses these species observed reactions to sonar and other active acoustic sources. Displaced animals would likely return after the major training exercise subsides within an area, as seen in the Bahamas study with Blainville's beaked whales (Tyack et al. 2011). This would allow the animal to recover from any energy expenditure or missed resources, reducing the likelihood of long-term consequences for the individual or population.

Training activities involving the coordination of multiple assets include Group Sail, anti-submarine warfare tactical development exercise, and integrated anti-submarine warfare course, which are responsible for about 21 percent of the predicted impacts on odontocetes. Although smaller in scale and shorter in duration than major training exercises discussed above, these events can still last for days and cover large parts of a range complex. Repeated exposures to some individual animals are likely in these events; however, due to the shorter duration and smaller footprint as compared to major training exercises, impacts from these activities are likely to be less severe. Long-term consequences for individuals or populations would not be expected.

Unit level training activities, including anti-submarine warfare, mine warfare, and navigation and object detection activities, are responsible for about 49 percent of the total impacts on odontocetes. These activities often involve the use of a single vessel, perhaps participating with an aircraft, but overall activity is limited and lasts for only a few hours over a small area of ocean. Given the short duration of these activities, they often occur close to homeports and in the same general locations each time. These conditions could result in resident animals more frequently being exposed to these types of activities. These training activities are very limited in scope and duration, so significant behavioral reactions are not expected in most cases. Long-term consequences for individuals or populations would not be expected.

Submarine and surface ship sonar maintenance is responsible for about 9 percent of the total predicted acoustic impacts on odontocetes from sonar and other active acoustic sources; however, maintenance events always involve the use of a single system being used in a limited manner either pierside or in the open ocean. Because of the very low activity level and short duration of these events and because many of these events are proposed in high-use ports, significant behavioral reactions are not expected in most cases. Long-term consequences for individuals or populations would not be expected.

Sperm Whales (ESA-Listed)

Sperm whales (classified as mid-frequency cetaceans [Section 3.4.2.3.2, Mid-Frequency Cetaceans]) may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that sperm whales could be exposed to sound that may result in 92 TTS and 6,623 behavioral reactions. Sperm whales within the Study Area belong to one of three stocks: North Atlantic; Gulf of Mexico Oceanic; or Puerto Rico and U.S. Virgin Islands. Predicted effects on sperm whales within the Gulf of Mexico are presumed to primarily impact the Gulf of Mexico Oceanic stock, whereas the majority of impacts predicted offshore of the east coast would impact the North Atlantic stock.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that if sperm whales are exposed to sonar or other active acoustic sources, they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Sperm whales have shown resilience to acoustic and human disturbance, although they may react to sound sources and activities within a few kilometers. Sperm whales that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, avoid the area by swimming away or diving, or display aggressive behavior. Long-term consequences for individuals or populations would not be expected.

Animals that do experience TTS may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations until their hearing recovers. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. Considering these factors, and the low number of overall predicted impacts, long-term consequences for individuals or populations would not be expected.

Dolphins and Small Whales (Delphinids)

Dolphins (classified as mid-frequency cetaceans [Section 3.4.2.3.2, Mid-Frequency Cetaceans]) may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that delphinids (17 species total) could be exposed to sound that may result in 37,616 TTS and 744,301 behavioral reactions. Most delphinid species are separated into two stocks within the Study Area: the Western North Atlantic and Gulf of Mexico. Predicted impacts on delphinids within the Gulf of Mexico are presumed to be primarily to the Gulf of Mexico stocks, whereas the majority of impacts predicted offshore of the east coast would be to the Western North Atlantic stocks. Bottlenose dolphins are divided into one oceanic and many coastal stocks along the east coast. The majority of exposures to bottlenose dolphins are likely to the oceanic stock with the exception of nearshore and in-port events, which could expose animals in coastal stocks.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that if delphinids are exposed to sonar or other active acoustic sources, they may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Delphinids may not react at all until the sound source is approaching within a few hundred meters to within a few kilometers, depending on the species. Delphinids that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, change their behaviors or vocalizations, avoid the sound source by swimming away or diving, or be attracted to the sound source. Long-term consequences to individual delphinids or populations are not likely due to exposure to sonar or other active acoustic sources.

Costs and long-term consequences to the individual and population resulting from a marine mammal receiving a TTS are discussed in the sections above (see Sperm Whales). Population level consequences are not expected.

Beaked Whales

Beaked whales may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that beaked whales (six species total) could be exposed to sound that may result in 204 TTS and 67,906 behavioral reactions. Most beaked whale species are separated into two stocks within the Study Area: the Western North Atlantic and Gulf of Mexico. Predicted impacts on beaked whales within the Gulf of Mexico are presumed to primarily impact the Gulf of Mexico stocks, whereas the majority of effects predicted offshore of the east coast would impact the Western North Atlantic stocks.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that if beaked whales are exposed to sonar or other active acoustic sources they may startle, break off feeding dives, and avoid the area of the sound source to levels of 157 dB re 1 μPa, or below (McCarthy et al. 2011). Furthermore, in research done at the Navy's fixed tracking range in the Bahamas, animals leave the immediate area of the anti-submarine warfare training exercise but return within a few days after the event ends. Populations of beaked whales and other odontocetes on the Bahamas, and other Navy fixed ranges that have been operating for tens of years, appear to be stable (Section 3.4.3.1.6, Marine Mammal Monitoring during Navy Training). Significant behavioral reactions seem likely in most cases if beaked whales are exposed to anti-submarine sonar within a few tens of kilometers (Section 3.4.3.1.8.1, Range to Effects), especially for prolonged periods (a few hours or more) since this is one of the most sensitive marine mammal groups to anthropogenic sound of any species or group studied to date.

Costs and long-term consequences to the individual and population resulting from a marine mammal receiving a TTS are discussed in the sections above (see Sperm Whales). Population level consequences are not expected.

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 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.”

Therefore, the Navy is requesting up to 10 serious injury or mortality takes for beaked whale species per year, and no more than 10 serious injury or mortality takes for beaked whale species over a five-year period. This approach overestimates the potential effects on marine mammals associated with Navy sonar training in the Study Area, as no mortality or serious injury of any species is anticipated. This request will be made even though almost 40 years of conducting similar exercises without observed incident in the operating environments represented in the Study Area indicate that injury, strandings, and mortality are not expected to occur resulting from Navy activities.

Neither NMFS nor the Navy anticipates 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.

Pygmy and Dwarf Sperm Whales (*Kogia* spp.)

Pygmy and dwarf sperm whales (genus: *Kogia*) may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that pygmy and dwarf sperm whales could be exposed to sound that may result in 5 PTS; 1,995 TTS; and 104 behavioral reactions. The majority of predicted impacts on these species are within the JAX and GOMEX Range Complexes. *Kogia* species are separated into two stocks within the Study Area: the Western North Atlantic and Gulf of Mexico Oceanic. Predicted impacts on pygmy and dwarf sperm whales within the Gulf of Mexico are presumed to be primarily to the Gulf of Mexico stocks, whereas the majority of impacts predicted offshore of the east coast would be to the Western North Atlantic stocks.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) on *Kogia* species are limited. However, these species tend to avoid human activity and presumably anthropogenic sounds. Pygmy and dwarf sperm whales may startle and leave the immediate area of the anti-submarine warfare training exercise. Significant behavioral reactions seem more likely than with most other odontocetes; however, it is unlikely that animals would receive multiple exposures over a short period, allowing animals time to recover lost resources (e.g., food) or opportunities (e.g., mating). Therefore, long-term consequences for individual *Kogia* or their respective populations are not expected.

Costs and long-term consequences to the individual and population resulting from a marine mammal receiving a TTS are discussed above. Population-level consequences are not expected.

Harbor Porpoises

Harbor porpoises may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that harbor porpoises could be exposed to sound that may result in 57 PTS; 18,955 TTS; and 117,605 behavioral reactions. Predicted impacts on this species are within the VACAPES and Northeast Range Complexes, primarily within inland waters and in the Northeast U.S. Continental Shelf Large Marine Ecosystem. All harbor porpoises within the Study Area belong to the Gulf of Maine/Bay of Fundy Stock, and therefore all predicted impacts would be on this stock.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) of harbor porpoises show that this small species is very wary of human activity and will avoid anthropogenic sound sources in many situations at levels down to 120 dB re 1 μPa. This level was determined by observing harbor porpoise reactions to acoustic deterrent and harassment devices used to drive away animals from around fishing nets and aquaculture facilities. Avoidance distances typically were about 1 km or more, but it is unknown if animals would react similarly if the sound source were at a distance of tens or hundreds of kilometers. The behavioral response function is not used to estimate behavioral responses by harbor porpoises; rather, a single threshold is used. Because of this very low behavioral threshold (120 dB re 1 μPa) for harbor porpoises, animals at distances exceeding 200 km in some cases are predicted to have a behavioral reaction in this acoustic analysis. It is not known whether animals would actually react to sound sources at these ranges, regardless of the received sound level. Harbor porpoises may startle and leave the immediate area of the anti-submarine warfare training exercise but return within a few days after the cessation of the event. Significant behavioral reactions seem more likely than with most other odontocetes. Since these species are typically found in nearshore and inshore habitats, animals that are resident during all or part of the year near Navy ports or fixed ranges could receive multiple exposures over a short period and throughout the year. Animals that do exhibit a significant behavioral reaction would likely recover from any incurred costs, reducing the likelihood of long-term consequences for the individual or population.

PTS and TTS are predicted for harbor porpoises. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age. Consequences for the population would not be expected even if a few individuals suffered long-term consequences because harbor porpoise populations number in the tens of thousands.

Phocid Seals

Predicted effects on pinnipeds from annual training activities under the No Action Alterative from sonar and other active acoustic sources indicate that three species of phocid seals (i.e., gray, harbor, and hooded seals) could be exposed to sound that may result in 63 behavioral reactions; these impacts happen almost entirely within the Northeast Range Complexes. Predicted impacts on phocid seals are from submarine sonar maintenance (about 57 percent), submarine tracking exercise/torpedo exercise events (about 40 percent), and submarine navigational activities within the VACAPES and Northeast Range Complexes and adjacent Navy ports (e.g., Norfolk) (approximately 3 percent). These activities use anti-submarine warfare hull-mounted sonar. As discussed in Section 3.4.3.1.8.1 (Range to Effects) ranges to TTS for hull-mounted sonar (e.g., sonar bin MF1; SQS-53) can be several kilometers for phocid seals. Some behavioral impacts could hypothetically take place at distances exceeding 100 km, although significant behavioral impacts are much more likely at higher received levels within a few kilometers of the sound source. Bearded and ringed seals are rare in the Study Area and would generally not occur in areas proposed for training activities that use sonar and other active acoustic sources. The acoustic model predicted no exposures to these two species.

Impacts are predicted to occur mostly within the Northeastern U.S. Continental Shelf Large Marine Ecosystem, with some effects predicted for the Gulf Stream Open Ocean Area. The hooded, gray, and harbor seals are all part of their species' respective Western North Atlantic stocks. Therefore, all predicted exposures to pinnipeds are associated with the species’ single stock represented within the Study Area.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that pinnipeds in the water are tolerant of anthropogenic noise and activity. If seals are exposed to sonar or other active acoustic sources, 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. Seals 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 seals or populations are unlikely.

Recovery from a hearing threshold shift (i.e., partial hearing loss- TTS) can take a few minutes to a few days depending on the severity of the initial shift. More severe shifts may not fully recover and thus would be considered PTS. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age.

Manatees (ESA-Listed)

The manatee is considered an inshore species, with most sightings occurring in warm fresh and brackish water, estuaries, and extremely nearshore coastal waters. During winter, manatees are largely restricted to Florida. Distribution expands northward into southeastern Georgia and beyond and westward in the Gulf of Mexico during warmer months.

Predicted impacts on manatees from training activities that use sonar and other active acoustic sources under the No Action Alterative are due to surface ship object detection at Mayport, Florida. All impacts on manatees are predicted within the JAX Range Complex at Mayport, Florida. This activity uses hull-mounted mid-frequency active sonar to locate underwater objects that may impede transit in and out of port. As discussed in Section 3.4.3.1.8.1 (Range to Effects), ranges to some behavioral impacts could take place at distances exceeding 100 km; however, only a very small percentage of marine mammals would be expected to react to the low received levels at these long distances. Significant behavioral impacts are much more likely at higher received levels within a few kilometers of the sound source.

West Indian manatees may be exposed to sonar or other active acoustic stressors associated with training activities throughout the year. The acoustic analysis predicts that manatees at Mayport, Florida could be exposed to sound that may result in 9 behavioral reactions. However, a single density estimate was applied across all seasons during the acoustic modeling process; therefore, differences in seasonal occurrence were not accounted for within the predicted impacts. In reality, manatee occurrence in the Mayport area where the acoustic impacts are predicted varies throughout the year with significantly lower densities during the colder winter months when the majority of the manatee population migrates to central and southern Florida. In addition, the predicted impacts do not factor in implementation of mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring), that are intended to reduce potential impacts from activities involving sonar and other active acoustic sources.

Manatees within the Port Canaveral and Mayport portions of the designated West Indian manatee critical habitat areas may be exposed to sound from sonar and other active acoustic sources. The primary constituent elements of the habitat required by the West Indian manatee for feeding and breeding have been reported as the presence of seagrasses and warm water refuges. These elements would not be impacted by the sound or energy from sonar or other active acoustic sources.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that manatees are generally tolerant, or perhaps habituated, to high levels of anthropogenic noise and activity. Manatees that did react have been observed alerting and swimming to deeper water in response to active acoustic sources. Manatees may not react at all until the sound source is approaching within a few hundred meters. Significant behavioral reactions would not be expected, and long-term consequences for individuals or populations are unlikely.

Conclusion

Training activities under the No Action Alternative include the use of sonar and other active acoustic sources as described in Table 2.8-1 and Section 3.0.5.3.1 (Acoustic and Explosive Stressors). These activities do not overlap bowhead whale, beluga whale, narwhal, walrus, or polar bear habitat. Therefore, it is very unlikely that these marine mammal species would be exposed to noise associated with these stressors.

It is important to note, as discussed in Section 3.4.3.1.5.6, that there are additional protections offered by mitigation measures (as described in detail in Chapter 5; Standard Operating Procedures, Mitigation, and Monitoring) which will further reduce potential impacts to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects.

Pursuant to the MMPA, the use of sonar and other active acoustic sources during training activities as described under the No Action Alternative:

- *may expose marine mammals up to 1,030,567 times annually to sound levels that would be considered Level B harassment;*
- *may expose marine mammals up to 64 times annually to sound levels that would be considered Level A harassment; and*
- *may expose up to 10 beaked whales annually and no more than 10 beaked whales in a five-year period to sound levels that may elicit stranding and subsequent serious injury or mortality.*

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under the No Action Alternative:

- *may affect and is likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whaled;*
- *may affect but is not likely to adversely affect the ESA-listed West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.8.5 No Action Alternative – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-2 and 2.8-3 in Section 3.0.5.3.1 (Acoustic and Explosive Stressors), testing activities under the No Action Alternative include activities that use sonar and other active acoustic sources that produce underwater sound. These activities would be concentrated in the Northeast Range Complexes and the Rhode Island inland waters, with lesser amounts of activity in the GOMEX Range Complex and the Naval Surface Warfare Center, Panama City Division Testing Range. VACAPES, JAX, and Key West Range Complexes also host a significant number of testing activities. Within these range complexes, activities involving the use of sonar and other active acoustic sources are concentrated on the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems and Gulf Stream Open Ocean Area.

Predicted acoustic impacts on marine mammals from exposure to sonar and other active acoustic sources for annually recurring testing activities under the No Action Alternative are shown in Table 3.4-16. Unmanned underwater vehicle demonstrations would be conducted under the No Action Alternative no more than once per five-year period at each of the following locations: Naval Surface Warfare Center, Panama City Division Testing Range and Naval Undersea Warfare Center Division, Newport Testing Range. Model predicted impacts for these nonrecurring activities (i.e., do not happen annually, but once over the five-year period) are shown in Table 3.4-18.

<u>Mysticetes</u>

About 50 percent of predicted impacts on mysticetes from annual testing activities under the No Action Alternative from sonar and other active acoustic sources would occur in the Northeast Range Complexes and testing ranges due primarily to submarine sonar testing and maintenance, torpedo testing, and unmanned underwater vehicle testing. About 30 percent of predicted impacts on mysticetes would occur at Naval Surface Warfare Center, Panama City Division Testing Range; the GOMEX Range Complex; and the Key West Range Complex due primarily to anti-submarine warfare sonar testing, unmanned underwater vehicle testing, and mine detection classification testing. Testing activities in the VACAPES and JAX Range Complexes are responsible for about 18 percent of the predicted impacts on mysticetes primarily due to unmanned underwater vehicle testing, torpedo testing, and submarine sonar testing.

North Atlantic Right Whales (ESA-Listed)

North Atlantic right whales may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year, especially in feeding grounds off the New England coast. The acoustic analysis predicts that North Atlantic right whales could be exposed to sound that may result in 2 TTS and 2 behavioral reactions. These impacts are predicted in Rhode Island inland waters and within the Northeast Range Complexes. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in 10 TTS over the five-year period. All predicted impacts would be to the Western North Atlantic stock because this is the only North Atlantic right whale stock present within the Study Area.

The sound from sonar and other active acoustic sources associated with training activities under the No Action Alternative would not impact the assumed primary constituent elements of the North Atlantic right whale critical habitat (i.e., water temperature and depth in the southeast and copepods in the northeast).

Predicted impacts are low overall. Costs and long-term consequences for individuals and populations due to exposure to sound levels that may cause TTS or behavioral reactions are discussed in Section 3.4.3.1.8.4 (No Action Alternative – Training Activities). Long-term consequences to the individual or population are not expected.

Humpback Whales (ESA-Listed)

Humpback whales may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year. The acoustic analysis predicts that humpback whales could be exposed to sound that may result in 10 TTS and 12 behavioral reactions. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in 3 TTS over the five-year period. All predicted impacts would be to the Gulf of Maine stock since this is the only humpback whale stock present within the Study Area.

Predicted impacts are low overall. Costs and long-term consequences for individuals and populations due to exposure to sound levels that may cause TTS or behavioral reactions are discussed in Section 3.4.3.1.8.4 (No Action Alternative – Training Activities). Long-term consequences to the individual or population are not expected.

Sei Whales (ESA-Listed)

Sei whales may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year. The acoustic analysis predicts that sei whales could be exposed to sound that may result in 21 TTS and 37 behavioral reactions. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in 15 TTS and 1 behavioral reaction over the five-year period, primarily at Naval Surface Warfare Center, Panama City Division Testing Range. All predicted impacts would be to the Nova Scotia stock because this is the only sei whale stock present within the Study Area.

Predicted impacts are low overall. Costs and long-term consequences for individuals and populations due to exposure to sound levels that may cause TTS or behavioral reactions are discussed in Section 3.4.3.1.8.4 (No Action Alternative – Training Activities). Long-term consequences to the individual or population are not expected.

Fin Whales (ESA-Listed)

Fin whales may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year. The acoustic analysis predicts that fin whales could be exposed to sound that may result in 21 TTS and 38 behavioral reactions. The majority of these impacts are predicted within the Northeast Range Complexes with lesser impacts in the VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in 44 TTS and 2 behavioral reactions over the five-year period, primarily at Naval Surface Warfare Center, Panama City Division Testing Range. All predicted impacts would be to the Western North Atlantic stock since this is the only fin whale stock present within the Study Area.

Predicted impacts are low overall. Costs and long-term consequences for individuals and populations due to exposure to sound levels that may cause TTS or behavioral reactions are discussed in Section 3.4.3.1.8.4 (No Action Alternative – Training Activities). Long-term consequences to the individual or population are not expected.

Blue Whales (ESA-Listed)

Blue whales may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year. The acoustic analysis predicts that one TTS and one behavioral reaction may result from annual testing activities that use sonar and other active acoustic sources. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in one TTS over the five-year period. All predicted impacts would be to the Western North Atlantic stock because this is the only blue whale stock present within the Study Area.

Predicted impacts are low overall. Costs and long-term consequences for individuals and populations due to exposure to sound levels that may cause TTS or behavioral reactions are discussed in Section 3.4.3.1.8.4 (No Action Alternative – Training Activities). Long-term consequences to the individual or population are not expected.

Minke and Bryde's Whales

Minke and Bryde's whales may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year. The acoustic analysis predicts that minke whales could be exposed to sound that may result in 337 TTS and 400 behavioral reactions, and Bryde's whale could be exposed to sound that may result in one TTS and two behavioral reactions. Nonrecurring unmanned underwater vehicle demonstrations could expose minke whales to sound that may result in 2 PTS, 660 TTS, and 29 behavioral reactions and Bryde’s whales to sound that may result in one TTS over the five-year period. All predicted effects on minke whales would be to the Canadian East Coast stock because this is the only stock present within the Study Area.

Costs and long-term consequences for individuals and populations due to exposure to sound levels that may cause TTS or behavioral reactions are discussed in Section 3.4.3.1.8.4 (No Action Alternative – Training Activities). Long-term consequences to the individual or population are not expected.

Odontocetes

Predicted effects on odontocetes from annual testing activities under the No Action Alterative from sonar and other active acoustic sources are primarily (approximately 96 percent) to harbor porpoises in the Northeast Range Complexes within the Northeastern U.S. Continental Shelf Large Marine Ecosystem primarily due to anti-submarine warfare tracking testing and torpedo testing. The remaining testing impacts under the No Action Alternative include anti-submarine warfare testing, stationary and semi-stationary source testing, and unmanned underwater vehicle testing. These activities would primarily occur within the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes.

Many testing events involve the use of a single sound source and have low levels of activity overall. More sensitive odontocetes (e.g., harbor porpoises, beaked whales, and pygmy and dwarf sperm whales) may avoid the area for the duration of the testing event. Because of the limited scope and duration of most testing events, significant behavioral reactions are not expected in most cases and model predicted results are likely an overestimate.

Sperm Whales (ESA-Listed)

Sperm whales may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year. The acoustic analysis predicts that sperm whales could be exposed to sound that may result in 10 TTS and 110 behavioral reactions. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in 30 TTS and one behavioral reaction over the five-year period. Sperm whales within the Study Area belong to one of three stocks: North Atlantic; Gulf of Mexico Oceanic; or Puerto Rico and U.S. Virgin Islands. Predicted impacts on sperm whales within the Gulf of Mexico are presumed to primarily impact the Gulf of Mexico Oceanic stock, whereas the majority of impacts predicted offshore of the east coast would impact the North Atlantic stock.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that if sperm whales are exposed to sonar or other active acoustic sources, they may react in a variety of ways, depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Sperm whales have shown resilience to acoustic and human disturbance, although they may react to sound sources and activities within a few kilometers. Sperm whales that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, avoid the area by swimming away or diving, or display aggressive behavior. Long-term consequences to the individual or population are not expected.

Costs and long-term consequences for individuals and populations due to exposure to sound levels that may cause TTS or behavioral reactions are discussed in Section 3.4.3.1.8.4 (No Action Alternative – Training Activities). Long-term consequences to the individual or population are not expected.

Dolphins and Small Whales (Delphinids)

Dolphins and small whales (delphinids) may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year. The acoustic analysis predicts that delphinids (17 species total) could be exposed to sound that may result in 3,117 TTS and 16,416 behavioral reactions. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in 10,852 TTS and 381 behavioral reactions over the five-year period. Most delphinid species are separated into two stocks within the Study Area: the Western North Atlantic and Gulf of Mexico. Predicted effects on delphinids within the Gulf of Mexico are presumed to primarily impact the Gulf of Mexico stocks, whereas the majority of effects predicted offshore of the east coast would impact the Western North Atlantic stocks. Bottlenose dolphins are divided into multiple coastal and one oceanic stock along the east coast. The majority of exposures to bottlenose dolphins are likely to the oceanic stock with the exception of nearshore and in-port events that could expose coastal animals.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that if dolphins are exposed to sonar or other active acoustic sources, they may react in a variety of ways, depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Delphinids may not react at all until the sound source is approaching within a few hundred meters to within a few kilometers depending on the species. Delphinids that are exposed to activities that involve the use of sonar and other active acoustic sources may alert, ignore the stimulus, change their behaviors or vocalizations, avoid the area by swimming away or diving, or be attracted to the sound source. Long-term consequences to individual dolphins or populations are not likely from exposure to sonar or other active acoustic sources.

Recovery from a hearing threshold shift (i.e., partial hearing loss- TTS) can take a few minutes to a few days, depending on the severity of the initial shift. More severe shifts may not fully recover and thus would be considered PTS. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age.

Beaked Whales

Beaked whales may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year. The acoustic analysis predicts that beaked whales (six species total) could be exposed to sound that may result in 16 TTS and 6,408 behavioral reactions. The majority of these impacts happen within the Northeast Range Complexes, with lesser effects in the VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in 65 TTS and 106 behavioral reactions over the five-year period. Most beaked whale species are separated into two stocks within the Study Area: the Western North Atlantic and Gulf of Mexico. Predicted effects on beaked whales within the Gulf of Mexico are presumed to primarily impact the Gulf of Mexico stocks, whereas the majority of effects predicted offshore of the east coast would impact the Western North Atlantic stocks.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that if beaked whales are exposed to sonar or other active acoustic sources they may startle, break off feeding dives, and avoid the area of the sound source to levels below 157 dB re 1 μPa (McCarthy et al. 2011). Significant behavioral reactions seem likely in most cases if beaked whales are exposed to sonar within a few tens of kilometers (Section 3.4.3.1.8.1, Range to Effects), especially for prolonged periods (a few hours or more) since this is one of the most sensitive marine mammal groups to anthropogenic sound of any species or group studied to date.

Costs and long-term consequences for individuals and populations due to exposure to sound levels that may cause PTS or TTS are discussed above for delphinids and would be similar for beaked whales. Long-term consequences to the individual or population are not expected.

Pygmy and Dwarf Sperm Whales (*Kogia* spp.)

Pygmy and dwarf sperm whales (genus: *Kogia*) may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year. The acoustic analysis predicts that pygmy and dwarf sperm whales could be exposed to sound that may result in 66 TTS and 7 behavioral reactions. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in 1 PTS and 48 TTS over the five-year period. *Kogia* species are separated into two stocks within the Study Area: the Western North Atlantic and Gulf of Mexico Oceanic. Predicted effects on pygmy and dwarf sperm whales within the Gulf of Mexico are presumed to primarily impact the Gulf of Mexico stocks, whereas the majority of effects predicted offshore of the east coast would impact the Western North Atlantic stocks.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) on *Kogia* species are limited, however these species tends to avoid human activity and presumably anthropogenic sounds. Pygmy and dwarf sperm whales may startle and leave the immediate area of the testing exercise but return within a few days after the end of the event. Significant behavioral reactions seem more likely than with most other odontocetes; however, it is unlikely that animals would receive multiple exposures over a short time period. Those that do exhibit a significant behavioral reaction may recover from any incurred costs, reducing the likelihood of long-term consequences for the individual or population.

Costs and long-term consequences for individuals and populations due to exposure to sound levels that may cause PTS or TTS are discussed above for delphinids and are assumed to be similar for dwarf and pygmy sperm whales. Long-term consequences for the individual or population are not expected.

Harbor Porpoises

Harbor porpoises may be exposed to sonar or other active acoustic stressors associated with testing activities throughout the year under the No Action Alternative. The acoustic analysis indicates that harbor porpoises could be exposed in annual testing activities to levels of sonar and other active acoustic sources resulting in 5 PTS; 23,948 TTS; and 692,605 behavioral responses. Almost all effects on harbor porpoises due to sonar and other active acoustic stressors proposed for use in testing activities would occur within the Northeast Range Complexes, with a few exposures within the VACAPES Range Complex. Nonrecurring, unmanned underwater vehicle demonstrations could expose animals to sound that may result in 17,326 TTS and 121,689 behavioral reactions over the five-year period at Naval Undersea Warfare Center Division, Newport Testing Range. All harbor porpoises within the Study Area belong to the Gulf of Maine/Bay of Fundy stock, and therefore all predicted impacts would be incurred to this stock.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) of harbor porpoises show that this small species is very wary of human activity and will avoid anthropogenic sound sources in many situations at levels down to 120 dB re 1 μPa. This level was determined by observing harbor porpoise reactions to acoustic deterrent and harassment devices used to drive away animals from around fishing nets and aquaculture facilities. Avoidance distances typically were 1 km or more, but it is unknown if an animals would react similarly if the sound source was located at a distance of tens or hundreds of kilometers. The behavioral response function is not used to estimate behavioral responses by harbor porpoises; rather, a single threshold is used. Because of this very low behavioral threshold (120 dB re 1 μPa) for harbor porpoises, in some cases animals at distances exceeding 200 km are predicted to have a behavioral reaction in this acoustic analysis. Since a large proportion of testing activities happen within harbor porpoise habitat in the northeast, predicted effects on this species are relatively greater than predicted effects for other marine mammals. Nevertheless, it is not known whether animals would actually react to sound sources at these ranges, regardless of the received sound level. Harbor porpoises may startle and leave the immediate area of the testing event but may return after the end of the event. Significant behavioral reactions seem more likely than with most other odontocetes, especially at closer ranges (within a few kilometers). Since these species are typically found in nearshore and inshore habitats, animals that are resident during all or part of the year near Navy ports or fixed ranges in the northeast could receive multiple exposures over a short period and throughout the year. Animals that do exhibit a significant behavioral reaction would likely recover from any incurred costs, reducing the likelihood of long-term consequences for the individual or population.

Animals that do experience hearing loss (PTS or TTS) may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age. Long-term consequences for the population would not be expected.

Phocid Seals

The acoustic analysis indicates that phocid seals could be exposed to sound that may result in 43 PTS, 4,032 TTS, and 455 behavioral reactions during annual testing activities using sonar and other active acoustic sources under the No Action Alterative; these impacts would happen almost entirely within the Northeast Range Complexes. Nonrecurring unmanned underwater vehicle demonstrations could expose animals to sound that may result in 31 PTS; 2,539 TTS; and 95 behavioral reactions over the five-year period at Naval Undersea Warfare Center Division, Newport Testing Range.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that pinnipeds in the water are tolerant of anthropogenic noise and activity. If seals are exposed to sonar or other active acoustic sources, they 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 seals or populations are unlikely.

Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age.

Manatees (ESA-Listed)

The manatee is considered an inshore species, with most sightings occurring in warm fresh and brackish water, estuaries, and extremely nearshore coastal waters. During winter, manatees are largely restricted to Florida. Distribution expands northward into southeastern Georgia and beyond, and westward in the Gulf of Mexico during warmer months.

Manatees may be exposed to sonar and other active acoustic sources during proposed testing activities in inland waters along the southeastern United States and Gulf of Mexico; however the Navy's acoustic model indicates no predicted effects from annual testing activities under the No Action Alterative using sonar and other active acoustic sources. The AFTT Draft EIS/OEIS previously stated that manatees could be exposed to sound that may result in TTS at Submarine Base Kings Bay, Georgia, from mid-frequency pierside sonar testing. Source level reductions in pierside testing are standard protocol, and a reduction of a minimum of 36 dB from full power for mid-frequency transmissions at Kings Bay will be implemented. Navy's acoustic model indicated no predicted effects for manatees, once this source level reduction was accounted for.

Manatees within the Port Canaveral and Mayport portions of the designated West Indian manatee critical habitat areas may be exposed to sound from sonar and other active acoustic sources. The primary constituent element of the habitat required by the West Indian manatee for feeding and breeding have been reported as the presence of seagrasses and warm water refuges. These elements would not be impacted by the sound or energy from sonar or other active acoustic sources.

Conclusion

Testing activities under the No Action Alternative include the use of sonar and other active acoustic sources as described in Table 2.8-2 to 2.8-3 and Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources). These activities do not overlap bowhead whale, beluga whale, narwhal, walrus, or polar bear habitat. Therefore, it is very unlikely that these marine mammal species would be exposed to sound associated with these stressors.

It is important to note, as discussed in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), that there are additional protections offered by mitigation measures (as described in detail in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) which will further reduce potential impacts to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects.

Pursuant to the MMPA, the use of sonar and other active acoustic sources during testing activities as described under the No Action Alternative:

- *may expose marine mammals up to 748,075 times annually to sound levels that would be considered Level B harassment;*
- *may expose marine mammals up to 48 times annually to sound levels that would be considered Level A harassment;*
- *may expose marine mammals up to 153,898 times over a five-year period associated with unmanned underwater vehicle demonstrations to sound levels that would be considered Level B harassment; and*
- *may expose marine mammals up to 34 times over a five-year period associated with unmanned underwater vehicle demonstrations to sound levels that would be considered Level A harassment.*

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under the No Action Alternative:

- *may affect and is likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *may affect but is not likely to adversely affect the ESA-listed West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.8.6 Alternative 1 – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1 and Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources), the number of annual training activities that produce in-water noise from the use of sonar and other active acoustic sources under Alternative 1 would increase. These activities would happen in the same general locations under Alternative 1 as under the No Action Alternative, with the following exceptions:

- Training activities under Alternative 1 were analyzed in areas both within and outside of Navy range complexes and OPAREAs, as well as in areas normally used by vessels crossing the Atlantic Ocean. Predicted impacts on mysticetes and odontocetes in these areas include 70,079 behavioral reactions and 2,115 TTS; however, many activities analyzed in these areas under

Alternative 1 were analyzed within range complexes under the No Action Alternative so that overall predicted impacts are similar for these activities.

- Airborne mine countermeasure training activities would increase in the GOMEX Range Complex to about 288 events per year from zero events under the No Action Alternative. Airborne mine countermeasure training activities have relatively low numbers of predicted acoustic impacts on marine mammals overall, so this change in activities does not present a notable change in predicted impacts.
- Ship mine countermeasure exercises that use ship mine detecting sonar would decrease in the GOMEX Range Complex from 274 events per year under the No Action Alternative to 20 events per year under Alternative 1 due to the introduction of the Littoral Combat Ship and the relocation of the mine countermeasure ships to the west coast. In turn, some of these events would move to the JAX and VACAPES Range Complexes, increasing to 48 events per year per area from no events under the No Action Alternative.

New training activities proposed under Alternative 1 and notable increases in numbers of activities from the No Action Alternative are as follows:

- Alternative 1 would include the mine warfare training activity civilian port defense, which is not included under the No Action Alternative. Table 3.4-16 lists predicted marine mammal impacts. Acoustic analysis predicts that a maximum of 1,420 behavioral reaction and 440 TTS on marine mammals could occur during each event. This could take place biennially in any of the following locations: Earle, New Jersey; Groton, Connecticut; Hampton Roads, Virginia; Morehead City, North Carolina; Wilmington, North Carolina; Kings Bay, Georgia; Mayport, Florida; Beaumont, Texas; or Corpus Christi, Texas. Predicted impacts associated with sonar and other active acoustic sources used in these events are very low due to the higher frequencies and lower power of mine detecting sonar (e.g., AN/AQS-20) used in these events. Predicted impacts on ESA-listed species include only one behavioral reaction from a sperm whale; however, all ESA-listed marine mammals within the Study Area could be exposed to sound from these events. Significant behavioral reactions would be unlikely for most species during these events.
- Two additional joint task force/sustainment exercises per year (four total) are proposed under Alternative 1, doubling the number of proposed events and therefore doubling the predicted impacts from these events to all species.
- Submarine under ice certification is a new activity proposed under Alternative 1, although acoustic analysis predictions show low impacts on marine mammals overall from sonar and other active acoustic sources used in this activity in the VACAPES and Northeast Range Complexes.
- Submarine sonar maintenance events would roughly double under Alternative 1 over the No Action Alternative. This would in turn double the predicted marine mammal impacts associated with this activity in the Northeast and VACAPES Range Complexes and in inland waters near Norfolk, Virginia.

The increase in proposed activities under Alternative 1 over the No Action Alternative would in turn lead to an approximately 99 percent increase in predicted acoustic impacts to marine mammal species. This could mean an increase in the number of individual animals exposed per year, or an increase in the number of times per year some individuals are exposed, although the types and severity of individual responses to sonar and other active acoustic sources are unlikely to change. Predicted acoustic impacts on marine mammals from exposure to sonar and other active acoustic sources for annually recurring training activities under Alternative 1 are shown in Table 3.4-14. Notable results for Alternative 1 are as follows:

- Predicted acoustic impacts on mysticetes overall would increase by about 122 percent. The most substantial differences in predicted impacts are within the VACAPES Range Complex. Under Alternative 1, one fin, one humpback, and one sei whale are predicted to suffer PTS that were not predicted under the No Action Alternative.
- Predicted acoustic impacts on ESA-listed sperm whales increase by about 120 percent for Alternative 1 as compared to the No Action Alternative. This is primarily due to increased proposed activity, and therefore predicted impacts, within the VACAPES Range Complex.
- Predicted acoustic impacts on dolphins and small-toothed whales increase by about 114 percent.
- Predicted acoustic impacts on beaked whales increase by about 100 percent. This is primarily due to increased joint task force/sustainment exercise and tracking exercise/torpedo exercise anti-submarine warfare activities in the JAX Range Complex leading to higher predicted behavioral reactions.
- Predicted acoustic impacts on harbor porpoises increase by about 3 percent, and predicted impacts on pygmy and dwarf sperm whales increase by about 141 percent.
- Predicted acoustic impacts on phocid seals increase by about 26 percent. No PTS are predicted.

Costs and long-term consequences for individuals and the population resulting from exposure to sonar and other active acoustic source sound and energy are discussed in Section 3.4.3.1.9.4 (No Action Alternative – Training Activities). Although the numbers and locations of the predicted reactions differ some between Alternative 1 and the No Action Alternative, the types and severity of reactions and the related consequences would be similar (Section 3.4.3.1.8.4, No Action Alternative – Training Activities).

Training activities involving sonar and other active acoustic sources proposed under Alternative 1 do not overlap bowhead whale, beluga whale, narwhal, walrus, or polar bear habitat. Therefore, it is very unlikely that these marine mammal species would be impacted by noise associated with proposed Navy training activities.

It is important to note, as discussed in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), that there are additional protections offered by mitigation measures (as described in detail in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) which will further reduce potential impacts to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects.

Pursuant to the MMPA, the use of sonar and other active acoustic sources during training activities as described under Alternative 1:

- *may expose marine mammals 2,049,956 times per year to sound levels that would be considered Level B harassment;*
- *may expose marine mammals 88 times per year to sound levels that would be considered Level A harassment;*
- *may expose marine mammals up to 1,860 times during each biennial civilian port defense activity to sound levels that would be considered Level B harassment;*
- *would not expose marine mammal to sound levels that would be considered Level A harassment during the biennial civilian port defense activities; and*
- *may expose up to 10 beaked whales annually and no more than 10 beaked whales over a five-year period to sound levels that may elicit stranding and subsequent serious injury or mortality.*

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under Alternative 1:

- *may affect and is likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *may affect but is not likely to adversely affect the ESA-listed West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.8.7 Alternative 1 – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-3, and Section 3.0.5.3.1 (Sonar and Other Active Acoustic Sources), the number of annual testing activities that produce in-water noise from the use of sonar and other active acoustic sources analyzed under Alternative 1 would increase over what was analyzed for the No Action Alternative (Section 3.4.3.1.9.5 describes predicted impacts on marine mammals under the No Action Alternative from testing activities). These activities would happen in the same general locations under Alternative 1 as under the No Action Alternative.

In addition to unmanned underwater vehicle demonstrations described under the No Action Alternative conducted once per five-year period at both Naval Surface Warfare Center, Panama City Division Testing Range and Naval Undersea Warfare Center Division, Newport Testing Range, one unmanned underwater vehicle demonstration per five-year period could be conducted at the South Florida Ocean Measurement Facility Testing Range near Fort Lauderdale under Alternative 1. See Table 3.4-17 for predicted marine mammal impacts. Predicted impacts associated with sonar and other active acoustic sources used in this event are relatively low. The ESA-listed species blue whale, humpback whale, sei whale, fin whale, and sperm whale all have predicted TTS. No PTS is predicted to ESA-listed species for this testing event.

The increase in proposed annual testing activities under Alternative 1 over the No Action Alternative would in turn lead to an approximately 89 percent increase in predicted impacts (behavioral reactions, TTS and PTS) to marine mammals due to an increase in proposed testing activities. This could increase the number of individual animals exposed per year or increase the number of times per year some animals are exposed, although the types and severity of individual responses to sonar and other active acoustic sources are unlikely to change. Predicted acoustic impacts on marine mammals from exposure to sonar and other active acoustic sources for annually recurring testing activities under Alternative 1 are shown in Table 3.4-15. Notable results for Alternative 1 are as follows:

- Predicted impacts on mysticetes increased by a factor of about nine times, and predicted impacts on ESA-listed mysticetes increased by a factor of about 10 times over the No Action Alternative. There is one predicted PTS to a minke whale per year for annual testing. All other predicted impacts on mysticetes are TTS and behavioral reactions.
- Predicted acoustic impacts on the ESA-listed sperm whale would increase by a factor of about 13 times over the No Action Alternative. Behavioral reactions and TTS are predicted; however, no PTS is predicted.
- Predicted acoustic impacts on delphinids from sonar and other active acoustic sources would increase by a factor of about eight times as compared to the No Action Alternative. Behavioral reactions and TTS are predicted; however, no PTS is predicted.
- Predicted acoustic impacts on beaked whales from sonar and other active acoustic sources would increase by a factor of about five times over the No Action Alternative. Behavioral reactions and TTS are predicted; however, no PTS is predicted.
- Predicted acoustic impacts on harbor porpoises would increase by approximately 68 percent compared to the No Action Alternative. Behavioral reactions, TTS, and PTS are predicted.
- Predicted acoustic impacts on pygmy and dwarf sperm whales from sonar and other active acoustic sources would increase by a factor of about 14 times compared to the No Action Alternative. This includes 5 PTS predictions not included under the No Action Alternative.
- Predicted acoustic impacts on phocid seals from sonar and other active acoustic sources would increase by a factor of about three times for Alternative 1 as compared to the No Action Alternative. Behavioral reactions, TTS, and PTS are predicted.

Costs and long-term consequences for individuals and the population resulting from exposure to sonar and other active acoustic source sound and energy are discussed above under the No Action Alternative. Although the numbers and locations of the predicted reactions differ some between Alternative 1 and the No Action Alternative, the types and severity of reactions and the related consequences would be similar (Section 3.4.3.1.9.5, No Action Alternative – Testing Activities).

Testing activities involving sonar and other active acoustic sources proposed under Alternative 1 do not overlap bowhead whale, beluga whale, narwhal, walrus, or polar bear habitat. Therefore, it is very unlikely that these marine mammal species would be impacted by noise associated with proposed Navy testing activities.

It is important to note, as discussed in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), that there are additional protections offered by mitigation measures (as described in detail in Chapter 5; Standard Operating Procedures, Mitigation, and Monitoring) which will further reduce potential impacts to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects.

Pursuant to the MMPA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 1:

- *may expose marine mammals up to 1,412,571 times annually to sound levels that would be considered Level B harassment;*
- *may expose marine mammals up to 169 times to sound levels that would be considered Level A harassment;*
- *may expose marine mammals up to 162,241 times over a five-year period associated with unmanned underwater vehicle demonstrations to sound levels that would be considered Level B harassment; and*
- *may expose marine mammals up to 35 times over a five-year period associated with unmanned underwater vehicle demonstrations to sound levels that would be considered Level A harassment.*

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 1:

- *may affect and is likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *may affect but is not likely to adversely affect the ESA-listed West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.8.8 Alternative 2 (Preferred Alternative) – Training Activities

Proposed training activities under Alternative 2 are identical to training activities proposed under Alternative 1. Therefore, the predicted impacts for Alternative 2 are identical to those described above in Section 3.4.3.1.9.6 (Alternative 1 – Training Activities).

It is important to note, as discussed in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), that there are additional protections offered by mitigation measures (as described in detail in Chapter 5; Standard Operating Procedures, Mitigation, and Monitoring) which will further reduce potential impacts to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects.

Pursuant to the MMPA, the use of sonar and other active acoustic sources during training activities as described under Alternative 2:

- *may expose marine mammals 2,049,956 times per year to sound levels that would be considered Level B harassment;*
- *may expose marine mammals 88 times per year to sound levels that would be considered Level A harassment;*
- *may expose marine mammals up to 1,860 times during each biennial civilian port defense activity to sound levels that would be considered Level B harassment;*
- *would not expose marine mammal to sound levels that would be considered Level A harassment during the biennial civilian port defense activities; and*
- *may expose up to 10 beaked whales annually and no more than 10 beaked whales over a five-year period to sound levels that may elicit stranding and subsequent serious injury or mortality.*

Appropriate authorization is being sought from the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. Table 3.4-14 and Table 3.4-16 present the Navy's marine mammal predicted exposures for training activities under Alternative 2.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under Alternative 2:

- *may affect and is likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale ;*
- *may affect but is not likely to adversely affect the ESA-listed West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.8.9 Alternative 2 (Preferred Alternative) – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-3, and Section 3.0.5.3.1 (Acoustic Stressors), the number of annual testing activities that produce in-water noise from the use of sonar and other active acoustic sources analyzed under Alternative 2 would increase over the No Action Alternative. Section 3.4.3.1.8.3 (Predicted Impacts from Sonar and Other Active Acoustic Sources) describes predicted impacts on marine mammals. These activities would happen in the same general locations under Alternative 2 as under the No Action Alternative.

Unmanned underwater vehicle demonstrations would be conducted once in the five-year period at each of the three proposed location under Alternative 2 as described under Alternative 1 above (Section 3.4.3.1.8.7, Alternative 1 – Testing Activities). Predicted impacts on marine mammals would be identical as shown in Table 3.4-17.

The increase in proposed annual testing activities under Alternative 2 over the No Action Alternative would in turn lead to approximately a 205 percent increase in predicted impacts (behavioral reactions, TTS, and PTS) to marine mammals due to annual testing activities. This could mean an increase in the number of individual animals exposed per year or an increase in the number of times per year some animals are exposed, although the types and severity of individual responses to sonar and other active acoustic sources are unlikely to change. Predicted acoustic impacts on marine mammals from exposure to sonar and other active acoustic sources for annually recurring testing activities under Alternative 2 are shown in Table 3.4-15. Notable results for Alternative 2 are as follows:

- Predicted impacts on mysticetes increase by a factor of about nine times, and predicted impacts on ESA-listed mysticetes increase by a factor of about 11 times. As with Alternative 1, there is one predicted PTS to a minke whale per year for annual testing. All other predicted impacts on mysticetes are TTS and behavioral reactions.
- Predicted acoustic impacts on ESA-listed sperm whales increase by a factor of about 14 times. Behavioral reactions and TTS are predicted; however, no PTS is predicted.
- Predicted acoustic impacts on delphinids increase by a factor of approximately nine times. Behavioral reactions and TTS are predicted; however, no PTS is predicted.
- Predicted acoustic impacts on beaked whales increase by a factor of approximately five times. Behavioral reactions and TTS are predicted; however, no PTS is predicted.
- Predicted acoustic impacts on harbor porpoises increase by a factor of approximately three times.
- Predicted acoustic impacts on pygmy and dwarf sperm whales increase by a factor of about 15 times.
- Predicted acoustic impacts on phocid seals increase by a factor of about three times.

Costs and long-term consequences for individuals and the population resulting from exposure to sonar and other active acoustic source sound and energy are discussed above under the No Action Alternative. Although the numbers and locations of the predicted reactions differ some between Alternative 2 and the No Action Alternative, the types and severity of reactions and the related consequences would be similar (Section 3.4.3.1.8.5, No Action Alternative – Testing Activities).

Testing activities involving sonar and other active acoustic sources proposed under Alternative 2 do not overlap bowhead whale, beluga whale, narwhal, walrus, or polar bear habitat. Therefore, it is very unlikely that these marine mammal species would be impacted by noise associated with proposed Navy testing activities.

It is important to note, as discussed in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), that there are additional protections offered by mitigation measures (as described in detail in Chapter 5; Standard Operating Procedures, Mitigation, and Monitoring) which will further reduce potential impacts to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects.

Pursuant to the MMPA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 2:

- *may expose marine mammals up to 2,278,338 times annually to sound levels that would be considered Level B harassment;*
- *may expose marine mammals up to 178 times to sound levels that would be considered Level A harassment;*
- *may expose marine mammals up to 162,241 times over a five-year period associated with unmanned underwater vehicle demonstrations to sound levels that would be considered Level B harassment; and*
- *may expose marine mammals up to 35 times over a five-year period associated with unmanned underwater vehicle demonstrations to sound levels that would be considered Level A harassment.*

Appropriate authorization is being sought from the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. Table 3.4-15 and Table 3.4-17 present the Navy's marine mammal predicted exposures for testing activities under Alternative 2.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 2:

- *may affect and is likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *may affect but is not likely to adversely affect the ESA-listed West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.9 Impacts from Explosives

Marine mammals could be exposed to energy and sound from underwater explosions associated with proposed activities.

Section 3.4.3.1.2.1 (Direct Injury) presents a review of observations and experiments involving marine mammals and reactions to impulsive sounds and underwater detonations. Energy from explosions is capable of causing mortality, direct injury, hearing loss, or a behavioral response depending on the level of exposure. The death of an animal would, of course, eliminate future reproductive potential and cause a long-term consequence for the individual that must then be considered for potential long-term consequences for the population. Exposures that result in long-term injuries such as 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 may recover quickly with little significant effect. 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). However, it is not clear how these responses relate to long-term consequences for the individual or population (National Research Council 2005).

Explosions in the ocean or near the water surface can introduce loud, impulsive, broadband sounds into the marine environment. These sounds are likely within the audible range of most cetaceans, but the duration of individual sounds is very short. The direct sound from explosions used during Navy training and testing activities last less than a second, and most events involve the use of only one or a few explosions. Furthermore, events are dispersed in time and throughout the Study Area. These factors reduce the likelihood of these sources causing substantial auditory masking in marine mammals.

3.4.3.1.9.1 Range to Effects

The following section provides the range to effects from an explosion to specific criteria using the Navy's explosive propagation model. Marine mammals within these ranges would be predicted to receive the associated effect. The range to effects is important information in estimating the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher-level effects, especially physiological effects such as injury and mortality.

The following section provides the range (distance) over which specific physiological or behavioral effects are expected to occur based on the explosive criteria (Section 3.4.3.1.4, Thresholds and Criteria for Predicting Acoustic and Explosive Impacts on Marine Mammals) and the explosive propagation calculations from the Navy Acoustic Effects Model (Section 3.4.3.1.5.3, Navy Acoustic Effects Model). The range to effects are shown for a range of explosive bins (Section 3.4.3.1.9.1, Range to Effects), from E2 (up to 0.5 lb. net explosive weight) to E17 (up to 58,000 lb. net explosive weight).

Figure 3.4-9 through Figure 3.4-14 show the range to slight lung injury and mortality for five representative animals of different masses for 0.5–58,000 lb. net explosive weight detonations. Modeled ranges for onset slight lung injury and onset mortality are based on the smallest calf weight in each category and therefore represents a conservative estimate (i.e., longer ranges) since populations contain many animals larger than calves that are less susceptible to injurious impacts. 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.

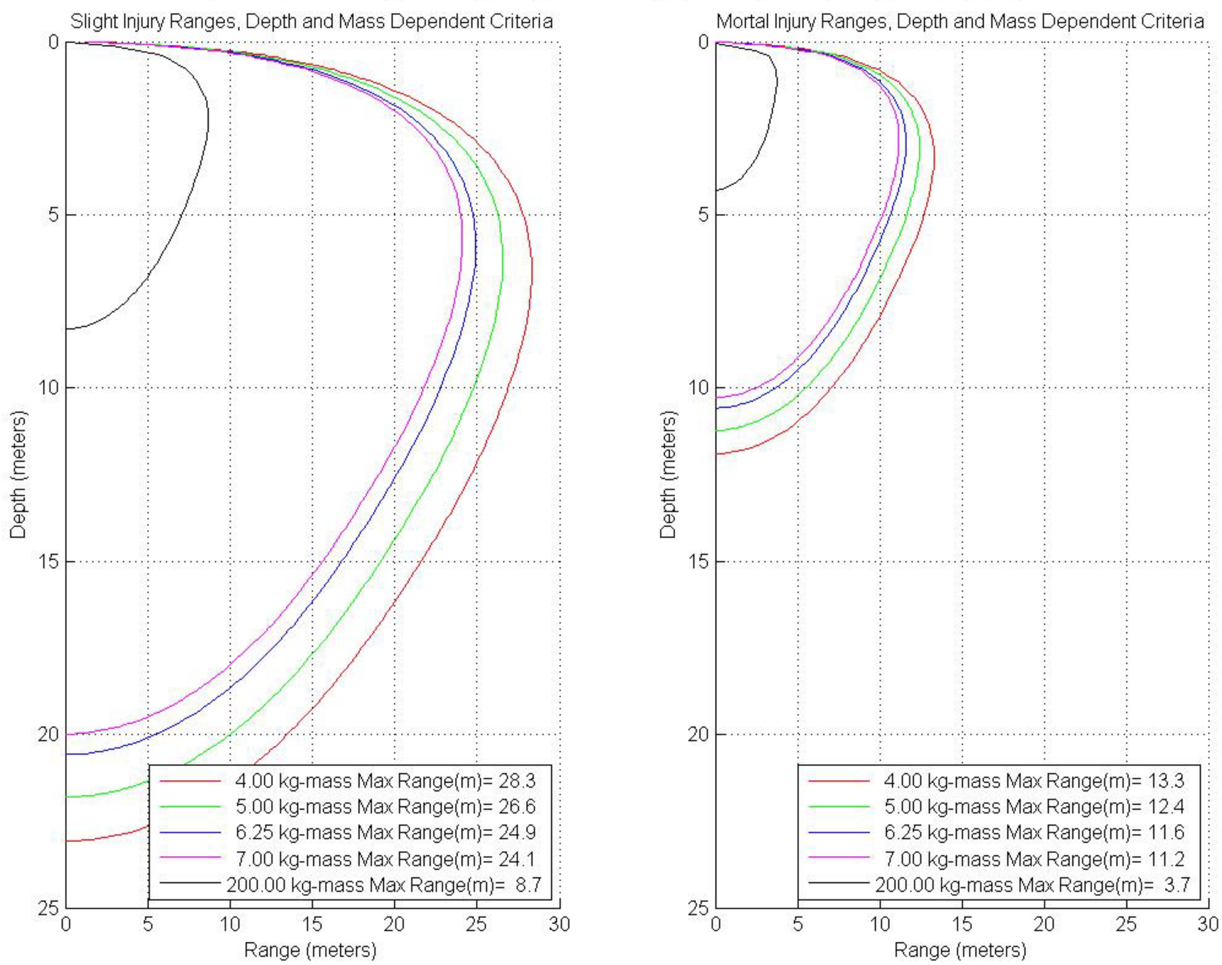


Figure 3.4-9: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses (4.0, 5.0, 6.25, 7.0, and 200 kg) for a 0.5-Pound Net Explosive Weight Charge (Bin E2) Detonated at 1-m Depth

m: meters; kg: kilogram

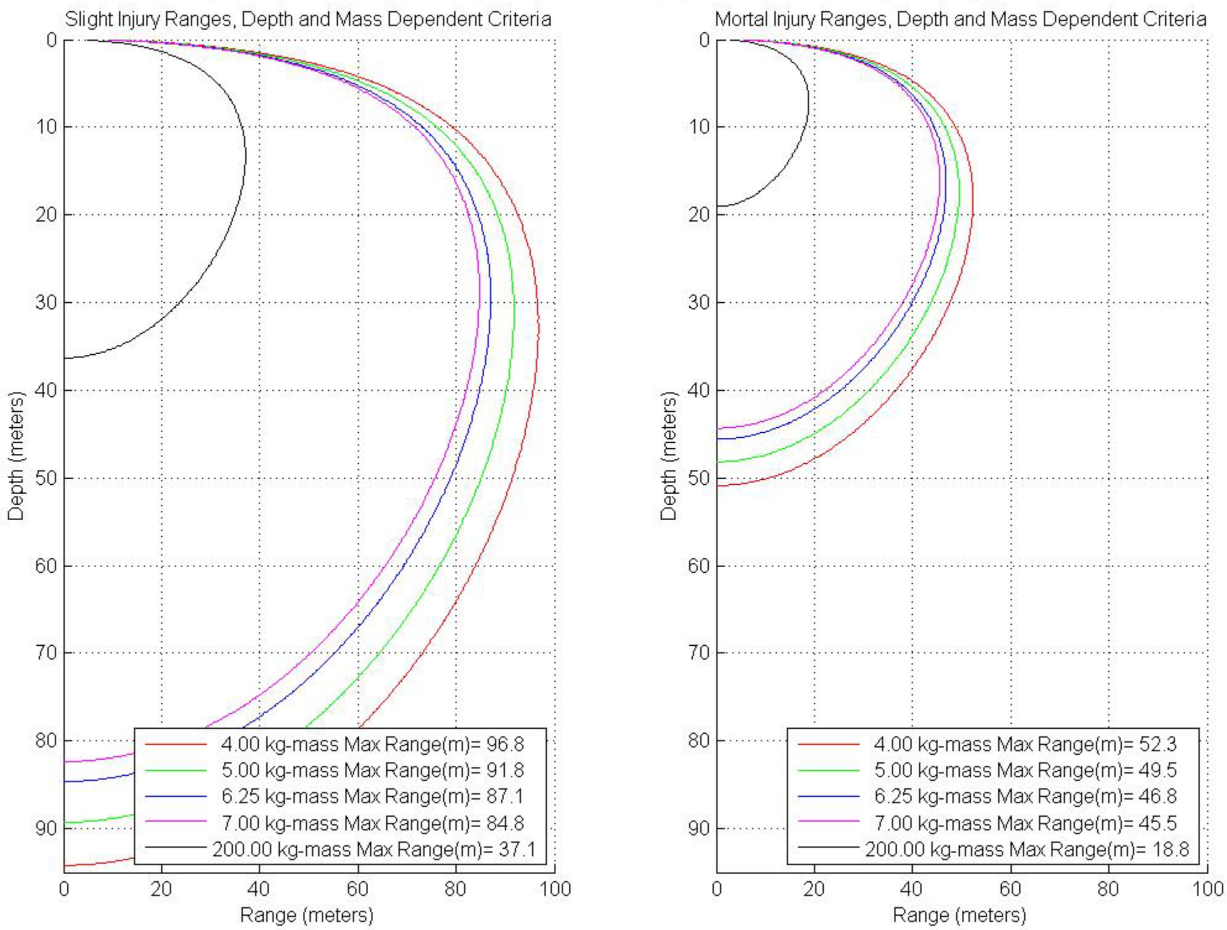


Figure 3.4-10: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses (4.0, 5.0, 6.25, 7.0, and 200 kg) for a 10-Pound Net Explosive Weight Charge (Bin E5) Detonated at 1-m Depth

m: meters; kg: kilogram

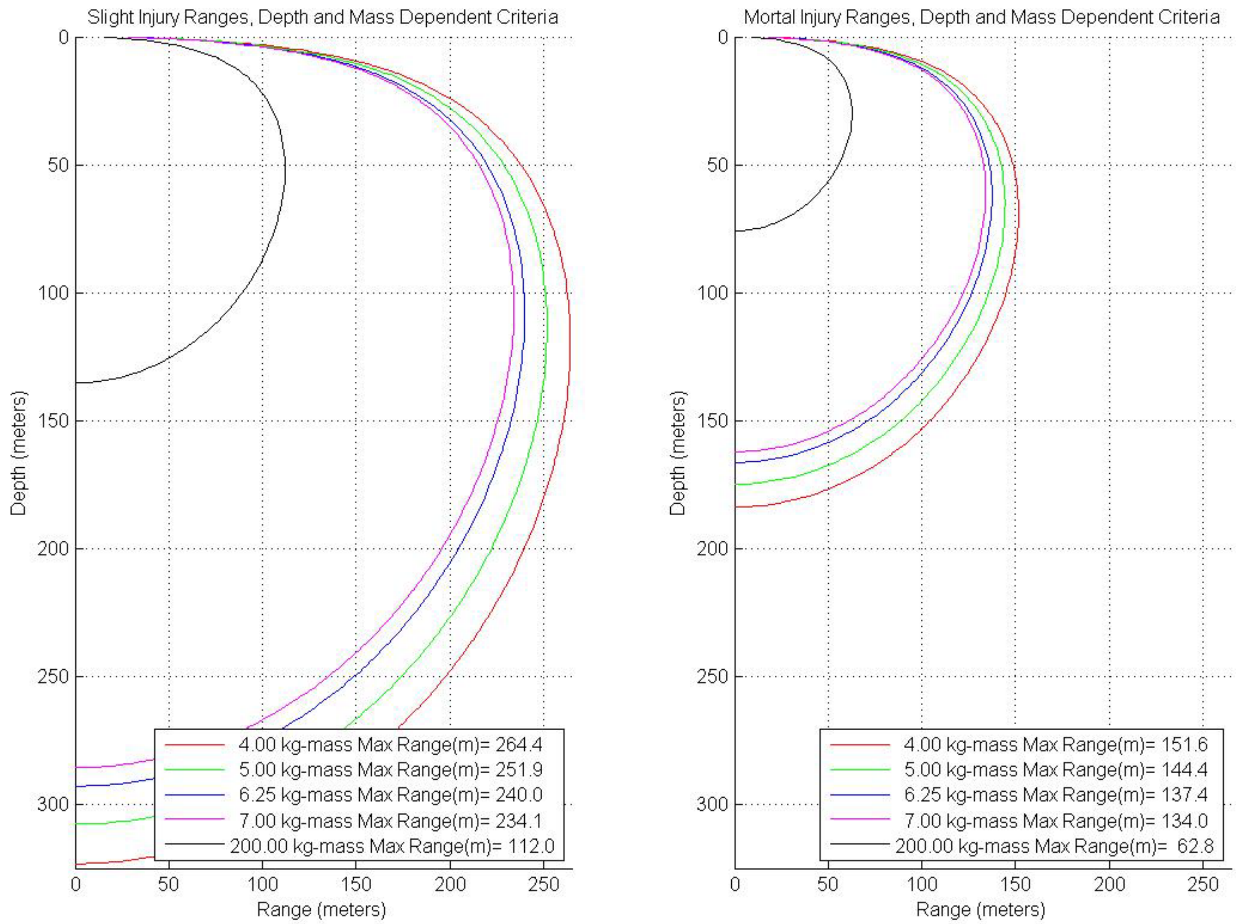


Figure 3.4-11: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses (4.0, 5.0, 6.25, 7.0, and 200 kg) for a 250-Pound Net Explosive Weight Charge (Bin E9) Detonated at 1-m Depth

m: meters; kg: kilogram

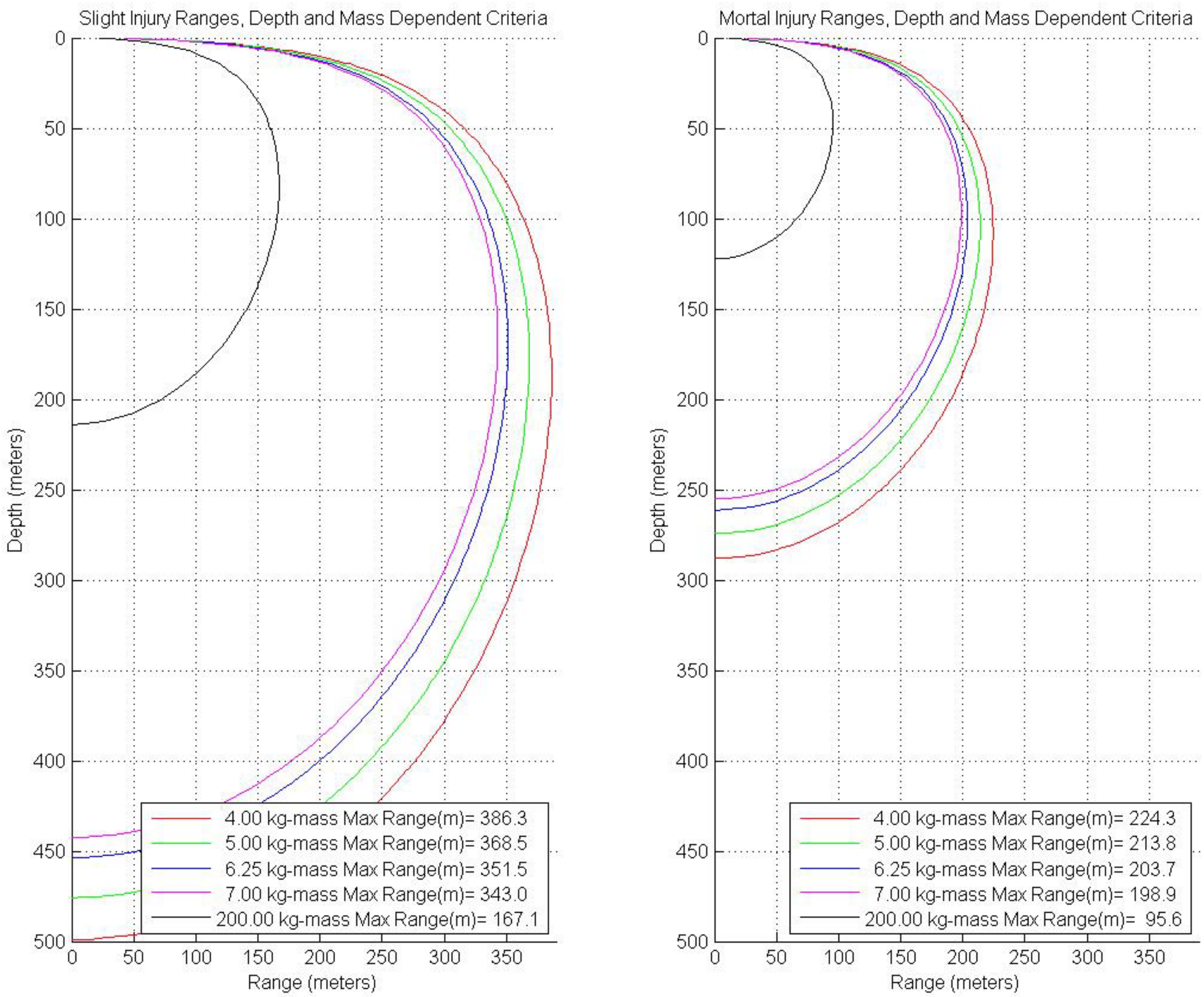


Figure 3.4-12: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses (4.0, 5.0, 6.25, 7.0, and 200 kg) for a 1,000-Pound Net Explosive Weight Charge (Bin E12) Detonated at 1-m Depth

m: meters; kg: kilogram

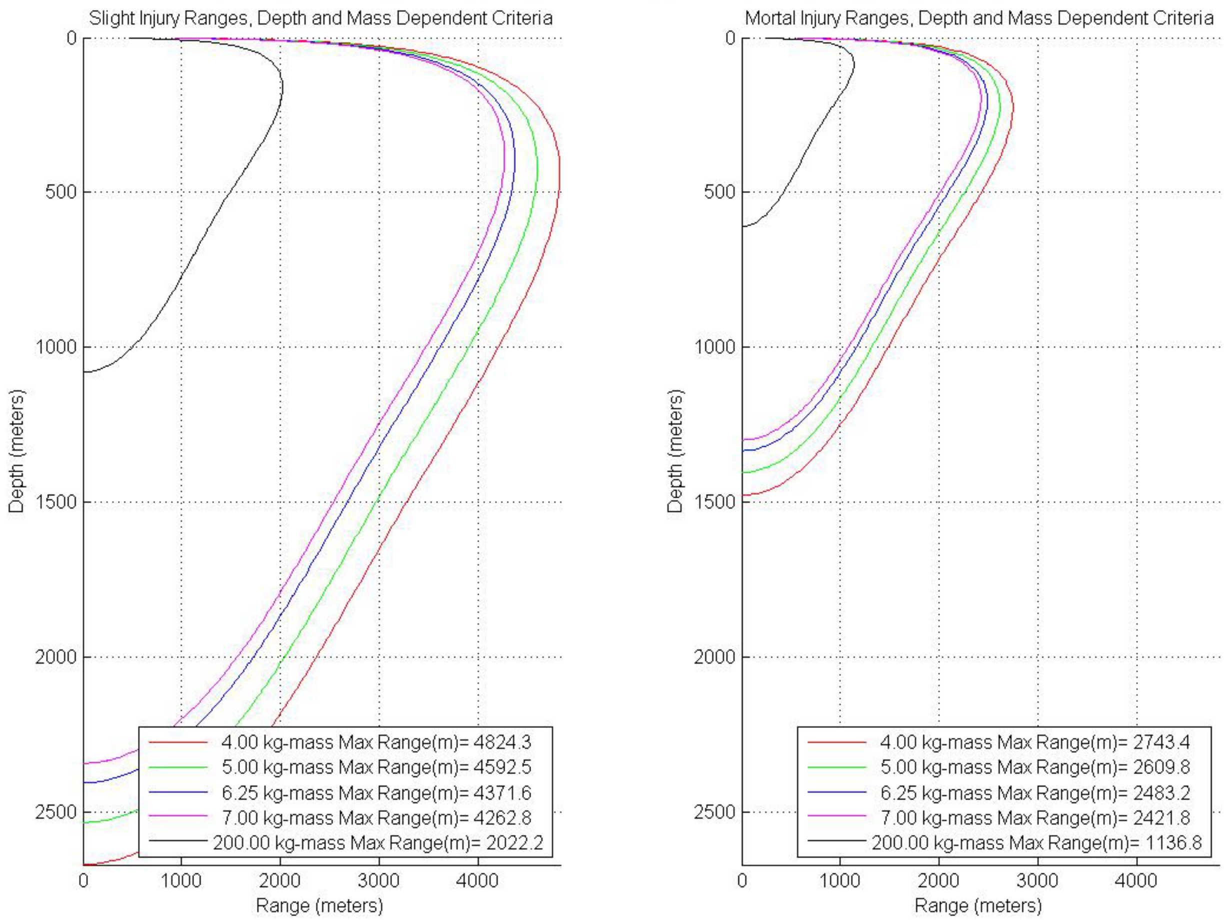


Figure 3.4-13: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses (4.0, 5.0, 6.25, 7.0, and 200 kg) for a 14,500-Pound Net Explosive Weight Charge (Bin E16) Detonated at 61-m Depth

m: meters; kg: kilogram

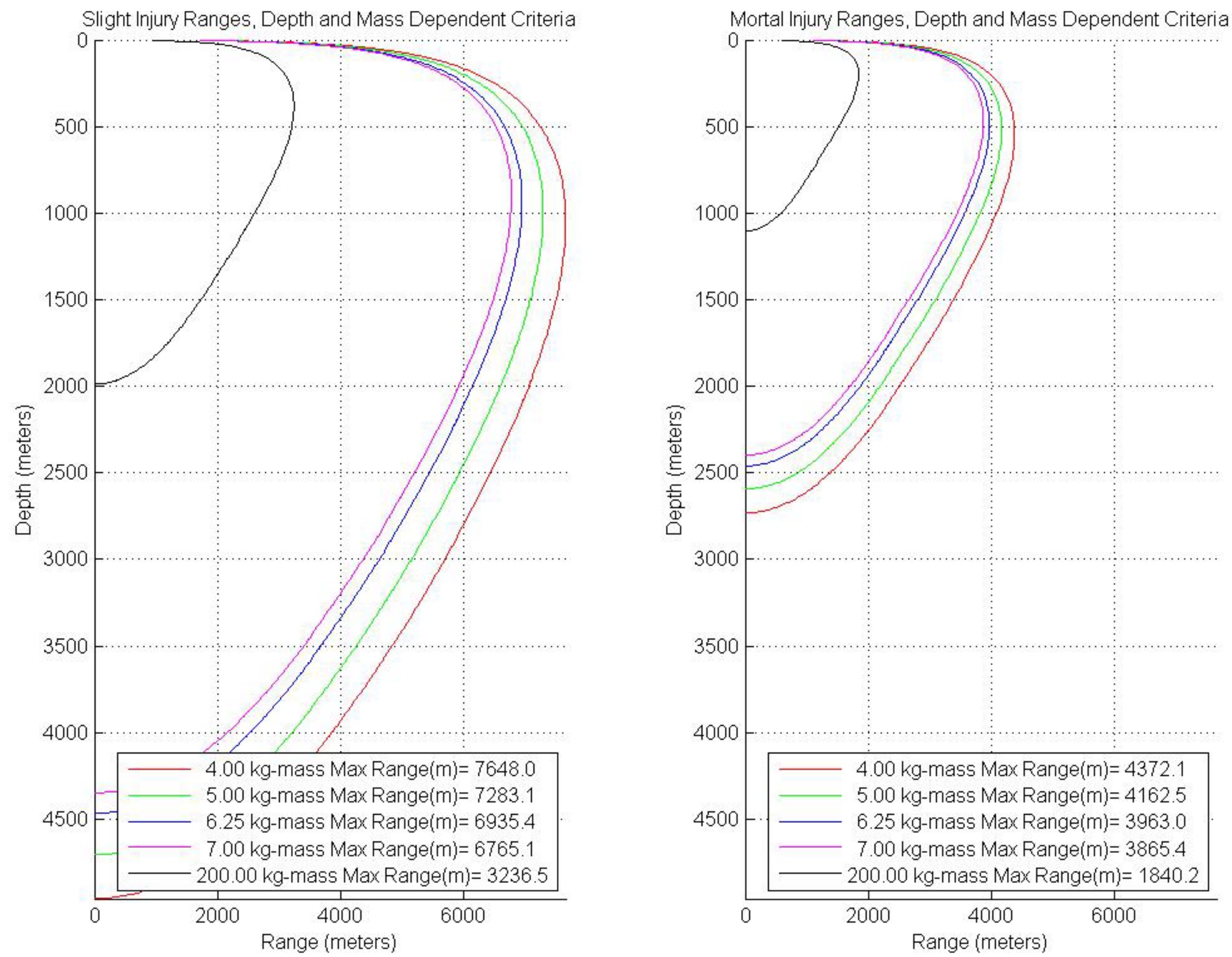


Figure 3.4-14: Threshold Profiles for Slight Lung Injury (left) and Mortality (right) Based on Five Representative Animal Masses (4.0, 5.0, 6.25, 7.0, and 200 kg) for a 58,000-Pound Net Explosive Weight Charge (Bin E17) Detonated at 61-m Depth
m: meters; kg: kilogram

The following tables (Table 3.4-19 through Table 3.4-22) show the average ranges to the potential effect based on the thresholds described in Section 3.4.3.1.4 (Thresholds and Criteria for Predicting Acoustic and Explosive Impacts to Marine Mammals). Similar to slight lung injury and mortality ranges discussed above, behavioral, TTS, and PTS ranges also represent conservative estimates (i.e., longer ranges) based on assuming all impulses are 1 second in duration. In fact, most impulses are much less than 1 second and therefore contain less energy than what is being used to produce the estimated ranges below.

Table 3.4-19: Average Range to Effects from Explosions for Low-Frequency Cetaceans across Representative Acoustic Environments within the Study Area

Criteria/Predicted Impact	Range to Effects (meters)					
	Bin E2 (0.5 lb. NEW)	Bin E5 (10 lb. NEW)	Bin E9 (250 lb. NEW)	Bin E12 (1,000 lb. NEW)	Bin E16 (14,500 lb. NEW)	Bin E17 (58,000 lb. NEW)
Onset Mortality	4	19	63	96	1,137	1,840
Onset Slight Lung Injury	9	37	112	167	2,022	3,237
Onset Slight GI Tract Injury	25	71	147	274	765	1,249
PTS	71	164	247	611	2,991	4,953
TTS	169	367	550	1,595	12,750	12,444
Behavioral Response	210	461	773	2,117	NA	NA

GI: Gastrointestinal; lb.: pound; NA: Behavioral Response Not Analyzed for bins E16 and E17 because these are single explosive events; NEW: net explosive weight; PTS: permanent threshold shift; TTS: temporary threshold shift

Table 3.4-20: Average Range to Effects from Explosions for Mid-Frequency Cetaceans across Representative Acoustic Environments within the Study Area

Criteria/Predicted Impact	Range to Effects (meters)					
	Bin E2 (0.5 lb. NEW)	Bin E5 (10 lb. NEW)	Bin E9 (250 lb. NEW)	Bin E12 (1,000 lb. NEW)	Bin E16 (14,500 lb. NEW)	Bin E17 (58,000 lb. NEW)
Onset Mortality	11	46	134	199	2,422	3,865
Onset Slight Lung Injury	24	85	234	343	4,263	6,765
Onset Slight GI Tract Injury	25	71	147	274	765	1,249
PTS	26	76	153	297	766	1,201
TTS	83	202	364	832	2,878	4,282
Behavioral Response	111	266	455	1,119	NA	NA

GI: Gastrointestinal; lb.: pound; NA: Behavioral Response Not Analyzed for bins E16 and E17 because these are single explosive events; NEW: net explosive weight; PTS: permanent threshold shift; TTS: temporary threshold shift

Table 3.4-21: Average Range to Effects from Explosions for High-Frequency Cetaceans across Representative Acoustic Environments within the Study Area

Criteria/Predicted Impact	Range to Effects (meters)					
	Bin E2 (0.5 lb. NEW)	Bin E5 (10 lb. NEW)	Bin E9 (250 lb. NEW)	Bin E12 (1,000 lb. NEW)	Bin E16 (14,500 lb. NEW)	Bin E17 (58,000 lb. NEW)
Onset Mortality	12	50	144	214	2,610	4,163
Onset Slight Lung Injury	27	92	252	369	4,593	7,283
Onset Slight GI Tract Injury	25	71	147	274	765	1,249
PTS	132	313	473	1,198	5,973	10,322
TTS	290	799	928	3,575	21,297	35,129
Behavioral Response	458	1,021	1,151	4,371	NA	NA

GI: Gastrointestinal; lb.: pound; NA: Behavioral Response Not Analyzed for bins E16 and E17 because these are single explosive events; NEW: net explosive weight; PTS: permanent threshold shift; TTS: temporary threshold shift

Table 3.4-22: Average Range to Effects from Explosions for Phocid Seals across Representative Acoustic Environments within the Study Area

Criteria/Predicted Impact	Range to Effects (meters)					
	Bin E2 (0.5 lb. NEW)	Bin E5 (10 lb. NEW)	Bin E9 (250 lb. NEW)	Bin E12 (1,000 lb. NEW)	Bin E16 (14,500 lb. NEW)	Bin E17 (58,000 lb. NEW)
Onset Mortality	13	52	152	224	2,743	4,372
Onset Slight Lung Injury	28	97	264	386	4,824	7,648
Onset Slight GI Tract Injury	25	71	147	274	765	1,249
PTS	70	158	359	824	2,914	4,733
TTS	150	433	787	1,870	12,655	11,663
Behavioral Response	194	561	967	2,305	NA	NA

GI: Gastrointestinal; lb.: pound; NA: Behavioral Response Not Analyzed for bins E16 and E17 because these are single explosive events; NEW: net explosive weight; PTS: permanent threshold shift; TTS: temporary threshold shift

3.4.3.1.9.2 Avoidance Behavior and Mitigation Measures as Applied to Explosives

As discussed above (Section 3.4.3.1.5.4, Model Assumptions and Limitations), within the Navy Acoustic Effects Model, animats (virtual animals) do not move horizontally or react in any way to avoid sound at any level. In reality, various researchers have demonstrated that cetaceans can perceive the location and movement of a sound source (e.g., vessel, seismic source, etc.) relative to their own location and react with responsive movement away from the source, often at distances of a kilometer or more (Au and Perryman 1982; Jansen et al. 2010; Richardson et al. 1995; Tyack et al. 2011; Watkins 1986; Wursig et al. 1998). Section 3.4.3.1.2.5 (Behavioral Reactions) reviews research and observations of marine mammals' reactions to sound sources including seismic surveys and explosives. The Navy Acoustic Effects Model also does not account for the implementation of mitigation, which would prevent many of the model-predicted injurious and mortal exposures to explosives. Therefore, the model-estimated mortality and injurious impacts are further analyzed considering avoidance and implementation of mitigation measures [see Section 3.4.3.1.5 (Quantitative Analysis) and the technical report *Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for Atlantic Fleet Training and Testing* (U.S. Department of the Navy 2013b)].

If explosive activities are preceded by multiple vessel traffic or hovering aircraft, harbor porpoises and beaked whales are assumed to move beyond the range to onset mortality before detonations occur, as discussed in Section 3.4.3.1.5.5 (Marine Mammal Avoidance of Sound Exposures). Table 3.4-20 and Table 3.4-21 show the ranges to onset mortality for mid-frequency and high frequency cetaceans for a representative range of charge sizes. The range to onset mortality for all net explosive weights (excluding ship shock charges) is generally less than 214 m, which is conservatively based on range to onset mortality for a calf (the maximum range to effects, excluding ship shock trials, is 300 m for source class E14). Because the Navy Acoustic Effects Model does not include avoidance behavior, the model-estimated mortalities are based on unlikely behavior for these species- that they would tolerate staying in an area of high human activity. Therefore, harbor porpoises and beaked whales that were model-estimated to experience mortality are assumed to move into the range of potential injury prior to the start of the explosive activity for the activities listed in Table 3.4-23.

Table 3.4-23: Activities Using Explosives Preceded by Multiple Vessel Movements or Hovering Helicopters

ACTIVITIES
Training
Civilian Port Defense
COMPTUEX
FIREX
Group Sail
GUNEX [S-S] – Boat – Medium-Caliber
GUNEX [S-S] – Ship – Medium-Caliber
JTFEX/SUSTAINEX
Maritime Security Operations – Anti-Swimmer Grenade
Mine Neutralization – EOD
Mine Neutralization – ROV
MISSILEX [A-S]
MISSILEX [S-S]
SINKEX
UNDET
Testing
[A-S] MISSILEX
Airborne Mine Neutralization Systems
Airborne Projectile-Based Mine Clearance System
Airborne Towed Mine Sweeping Test
ASW Tracking Test – Helo
At-Sea Explosives Testing
MCM Mission Package Testing
Mine Countermeasure/Neutralization Testing
NSWC: Mine Countermeasure/Neutralization Testing
NSWC: Stationary Source Testing
NUWC: Pierside Integrated Swimmer Defense
Pierside Integrated Swimmer Defense
Ship Shock Trials
Sonobuoy Lot Acceptance Testing
Torpedo (Explosive) Testing

Note: A-S: air to surface; ASW: anti-submarine warfare; COMPTUEX: composite training unit exercise; EOD: explosive ordnance disposal; FIREX: firing exercise; GUNEX: gunnery exercise; JTFEX: joint forces exercise; MCM: mine countermeasure; NSWC: Naval Surface Warfare Center, Panama City Testing Range; NUWC: Naval Undersea Warfare Center Division, Newport Testing Range; ROV: remotely operated vehicle; SINKEX: sinking exercise; S-S: surface to surface; SUSTAINEX: sustainment exercise; UNDET: underwater detonation

The Navy Acoustic Effects Model does not consider mitigation, discussed in detail in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). As explained in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), to account for the implementation of mitigation measures, the acoustic analysis assumes a model-predicted mortality or injury would not occur if an animal at the water surface would likely be observed during those activities with dedicated Lookouts up to and during the use of explosives, considering the mitigation effectiveness (Table 3.4-24) and sightability of a species based on g(0) (see Table 5.3-1). The mitigation effectiveness is considered over two regions of an activity's mitigation zone: (1) the range to onset mortality closer to the explosion and (2) range to onset PTS. The model-estimated mortalities and injuries are reduced by the portion of animals that are likely to be seen [Mitigation Effectiveness x Sightability, g(0)]; these animals are instead assumed to be present within the range to injury and range to TTS, respectively.

Table 3.4-24: Consideration of Mitigation in Acoustic Effects Analysis for Explosives

Activity[1,2]	Mitigation Effectiveness Factor for Acoustic Analysis		Mitigation Platform
	Injury Zone	Mortality Zone	
Training			
BOMBEX [A-S] (HF/Phocids/LF)	–	1	Aircraft
BOMBEX [A-S] (MF)	0.5	1	Aircraft
Civilian Port Defense	1	1	Vessel
COMPTUEX (IEER/Mine Neutralization Exercise)	0.5	0.5	Both[3]
Group Sail (IEER)	0.5	0.5	Aircraft
GUNEX [A-S] – Medium-Caliber (HF/Phocids)	0.5	0.5	Aircraft
GUNEX [A-S] – Medium-Caliber (MF/LF)	1	1	Aircraft
GUNEX [S-S] – Boat – Medium-Caliber (HF/Phocids)	0.5	0.5	Vessel
GUNEX [S-S] – Boat – Medium-Caliber (MF/LF)	1	1	Vessel
GUNEX [S-S] – Ship – Medium-Caliber (HF/Phocids)	0.5	0.5	Vessel
GUNEX [S-S] – Ship – Medium-Caliber (MF/LF)	1	1	Vessel
JTFEX-SUSTAINEX/SUSTAINEX (IEER)	0.5	0.5	Aircraft
Maritime Security Operations – Anti-Swimmer Grenade	1	1	
Mine Neutralization – EOD	0.5	1	Vessel
Mine Neutralization – ROV	1	1	Vessel
SINKEX (HF/Phocids/LF)	–	1	Aircraft
SINKEX (MF)	0.5	1	Aircraft
TRACKEX/TORPEX – MPA Sonobuoy	0.5	0.5	Aircraft
UNDET	1	1	Vessel
Testing			
[A-S] GUNEX (HF/Phocids)	0.5	0.5	Aircraft
[A-S] GUNEX (MF/LF)	1	1	Aircraft
Airborne Mine Neutralization Systems (HF/Phocids)	–	1	Both[3]
Airborne Mine Neutralization Systems (MF/LF)	1	1	Both[3]
Airborne Projectile-Based Mine Clearance System (HF/Phocids)	–	1	Both[3]
Airborne Projectile-Based Mine Clearance System (MF/LF)	1	1	Both[3]
Airborne Towed Mine Sweeping Test (HF/Phocids)	–	1	Both[3]
Airborne Towed Mine Sweeping Test (MF/LF)	1	1	Both[3]
Aircraft Carrier Sea Trial	1	1	Vessel
ASW Tracking Test – Helo	0.5	0.5	Aircraft
At-Sea Explosives Testing	1	1	Vessel
MCM Mission Package Testing	1	1	Vessel
Mine Countermeasure/Neutralization Testing	1	1	Vessel
NSWC: Mine Countermeasure/Neutralization Testing	1	1	Vessel
Ship Shock Trials	0.5	1	Both[4]
Sonobuoy Lot Acceptance Testing	1	1	Vessel
Torpedo (Explosive) Testing	–	1	Aircraft

[1] Ranges to effect differ for functional hearing groups based on weighted threshold values. HF: high frequency cetaceans; MF: mid-frequency cetaceans; LF: low frequency cetaceans

[2] If less than half of the mitigation zone can be continuously visually observed or if the mitigation zone cannot be visually observed during most of the scenarios within the activity due to the type of surveillance platform(s), number of Lookouts, and size of the mitigation zone, mitigation is not considered in the acoustic effects analysis of that activity and the activity is not listed in this table. For activities in which only mitigation in the mortality zone is considered in the analysis, no value is provided for the injury zone.

[3] Activity employs both vessel and aircraft based Lookouts. The larger g(0) value (aerial or vessel) is used.

[4] Activity employs vessel or aircraft based Lookouts. If vessels are the only platform, a sufficient number of vessel-based Lookouts will be used to effectively mitigate the area in a manner comparable to aerial mitigation.

Note: A-S: air-to-surface; ASW: anti-submarine warfare; BOMBEX: bombing exercise; COMPTUEX: composite unit training exercise; EOD: explosive ordnance disposal; GUNEX: gunnery exercise; HF: high-frequency; IEER: Improved Extended Echo Ranging; JTFEX: joint forces exercise; LF: low-frequency; MCM: mine countermeasure; MF: mid-frequency; MPA: maritime patrol aircraft; NSWC: Naval Surface Warfare Center; ROV: remotely operated vehicle; SINKEX: sinking exercise; S-S: surface-to-surface; SUSTAINEX: sustainment exercise; TORPEX: torpedo exercise; TRACKEX: tracking exercise; UNDET: underwater detonation

During an activity with a series of explosions (not concurrent multiple explosions)(see Table 3.4-25), an animal is expected to exhibit an initial startle reaction to the first detonation followed by a behavioral response after multiple detonations. At close ranges and high sound levels approaching those that could cause PTS, avoidance of the area around the explosions is the assumed behavioral response for most cases. The ranges to PTS for each functional hearing group for a range of explosive sizes (single detonation) are shown in Table 3.4-19 through Table 3.4-26. Animals not observed by Lookouts within the ranges to PTS at the time of the initial couple of explosions are assumed to experience PTS; however, animals that exhibit avoidance reactions beyond the initial range to PTS are assumed to move away from the expanding range to PTS effects with each additional explosion. Research has demonstrated that odontocetes have directional hearing, with best hearing sensitivity facing a sound source (Kastelein et al. 2005a; Mooney et al. 2008; Popov and Supin 2009). Therefore, an odontocete avoiding a source would receive sounds along a less sensitive hearing axis, potentially reducing impacts. Because the Navy Acoustic Effects Model does not account for avoidance behavior, the model-estimated effects are based on unlikely behavior – that animals would remain in the vicinity of potentially injurious sound sources. Therefore, only the initial exposures resulting in model-estimated PTS are expected to actually occur. The remaining model-estimated PTS are considered to actually be TTS due to avoidance.

Table 3.4-25: Activities with Multiple Non-Concurrent Explosions

ACTIVITIES
Training
BOMBEX [A-S]
Civilian Port Defense
FIREX
Maritime Security Operations – Antii-Swimmer Grenades
Mine Neutralization – EOD
Mine Neutralization – ROV
SINKEX
Testing
Airborne Mine Neutralization Systems
Airborne Projectile-Based Mine Clearance System
MCM Mission Package Testing
Mine Countermeasure/Neutralization Testing
NSWC: Mine Countermeasure/Neutralization Testing
NSWC: Ordnance Testing
NSWC: Stationary Source Testing
NUWC: Pierside Integrated Swimmer Defense
Pierside Integrated Swimmer Defense
Sonobuoy Lot Acceptance Testing

Note: A-S: air-to-surface; BOMBEX: bombing exercise; EOD: explosive ordnance disposal; FIREX: fire support exercise; GUNEX: gunnery exercise; MCM: mine countermeasure; NUWC: Naval Undersea Warfare Center Division, Newport; ROV: remotely operated vehicle; SINKEX: sinking exercise; S-S: surface-to-surface; UNDET: underwater detonation

3.4.3.1.9.3 Predicted Impacts from Explosives

Table 3.4-22 through Table 3.4-29 present the predicted impacts on marine mammals separated between training and testing activities, and between annual and nonannual events. Nonannual events, those events that may only take place a few times over the five-year period and do not reoccur every year, are considered separately since these impacts would not be assessed each year. This acoustic impact analysis uses the Navy Acoustic Effects Model (Section 3.4.3.1.5.3 [Navy Acoustic Effects Model]) followed by post-model consideration of avoidance and implementation of mitigation to predict effects using the explosive criteria and thresholds described in Section 3.4.3.1.4 (Thresholds and Criteria for Predicting Acoustic and Explosive Impacts to Marine Mammals).

The Navy Acoustic Effects Model does not account for several factors (Section 3.4.3.1.5.4 [Model Assumptions and Limitations]) that must be considered in the overall explosive analysis. When there is uncertainty in model input values, a conservative approach is often chosen to assure that potential effects are not under-estimated. As a result, the Navy Acoustic Effects Model provides estimates that are conservative (over-estimate the likely impacts). The following is a list of several such factors that cause the model to overestimate potential effects:

- The onset mortality criterion is based on the impulse at which one percent of the animals receiving an injury would not recover, leading to mortality. Therefore, many animals that are predicted to suffer mortality in this analysis may actually recover from their injuries.
- Slight lung injury criteria is based on the impulse at which one percent of the animals exposed would incur a slight lung injury from which full recovery would be expected. Therefore, many animals that are predicted to suffer slight lung injury in this analysis may actually not incur injuries.
- The metrics used for the threshold for slight lung injury and mortality (i.e., acoustic impulse) are based on the animal’s mass. The smaller an animal, the more susceptible that individual is to these effects. In this analysis, all individuals of a given species are assigned the weight of that species newborn calf or pup weight. Since many individuals in a population are obviously larger than a newborn calf or pup of that species, this assumption causes the acoustic model to overestimate the number of animals that may suffer slight lung injury or mortality. As discussed in the explanation of onset mortality and onset slight lung injury criteria in Section 3.4.3.1.4.1 (Mortality and Injury from Explosions), the volumes of water in which the threshold for onset mortality may be exceeded are generally less than a fifth for an adult animal versus a calf.
- Many explosions from munitions such as bombs and missiles actually occur upon impact with above-water targets. However, for this analysis, sources such as these were modeled as exploding at 1 m depth. This overestimates the amount of explosive and acoustic energy entering the water and therefore overestimates effects on marine mammals.

Impacts on manatees from explosive energy or sound are not predicted under any alternative for training or testing. Furthermore, explosive detonations do not occur within or near West Indian manatee critical habitat. These events would not take place in bearded and ringed seal habitat, and impacts from explosive energy or sound are not predicted under any alternative (training or testing) for these species. There are no predicted impacts on marine mammals from explosions associated with the testing activity aircraft carrier sea trial that could occur once per five-year period under Alternatives 1 and 2.

These predicted impacts shown below are the result of the acoustic analysis, including acoustic effect modeling followed by consideration of animal avoidance of multiple exposures, avoidance of areas with high level of activity by sensitive species, and mitigation. It is important to note that acoustic impacts presented in Table 3.4-22 through Table 3.4-29 are the total number of impacts and not necessarily the number of individuals impacted. As discussed in Section 3.4.3.1.4.5 (Behavioral Responses), an animal

Table 3.4-26: Predicted Impacts per Year from Explosions for Annually Recurring Training Activities under the No Action Alternative

Species	Behavioral Response	TTS	PTS	GI Tract Injury	Onset Slight Lung Injury	Onset Mortality
Mysticetes						
Blue Whale*	0	0	0	0	0	0
Bryde's Whale	0	0	0	0	0	0
Minke Whale	3	9	1	0	0	0
Fin Whale*	0	0	0	0	0	0
Humpback Whale*	0	0	0	0	0	0
North Atlantic Right Whale*	0	0	0	0	0	0
Sei Whale*	0	1	0	0	0	0
Odontocetes – Delphinids						
Atlantic Spotted Dolphin	5	10	1	0	4	2
Atlantic White-Sided Dolphin	2	2	0	0	1	0
Bottlenose Dolphin	8	10	1	0	2	1
Clymene Dolphin	1	1	0	0	1	0
Common Dolphin	11	15	1	0	9	4
False Killer Whale	0	0	0	0	0	0
Fraser's Dolphin	0	0	0	0	0	0
Killer Whale	0	1	0	0	0	0
Melon-Headed Whale	1	0	0	0	0	0
Pantropical Spotted Dolphin	13	9	0	0	11	3
Pilot Whale	3	4	0	0	1	0
Pygmy Killer Whale	0	0	0	0	0	0
Risso's Dolphin	6	6	0	0	1	0
Rough-Toothed Dolphin	0	0	0	0	0	0
Spinner Dolphin	2	1	0	0	1	0
Striped Dolphin	6	6	0	0	5	2
White-Beaked Dolphin	0	0	0	0	0	0
Odontocetes – Sperm Whale						
Sperm Whale*	0	0	0	0	0	0
Odontocetes – Beaked Whales						
Blainville's Beaked Whale	0	0	0	0	0	0
Cuvier's Beaked Whale	0	0	0	0	0	0
Gervais' Beaked Whale	0	0	0	0	0	0
Northern Bottlenose Whale	0	0	0	0	0	0
Sowerby's Beaked Whale	0	0	0	0	0	0
True's Beaked Whale	0	0	0	0	0	0
Odontocetes – *Kogia* Species and Porpoises						
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	0	3	1	0	0	0
Harbor Porpoise	9	120	53	0	3	1
Phocid Seals						
Gray Seal	0	0	0	0	0	0
Harbor Seal	0	0	0	0	0	0
Harp Seal	0	0	0	0	0	0
Hooded Seal	0	0	0	0	0	0

GI: gastrointestinal; PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA-listed species

Table 3.4-27: Predicted Impacts per Year from Explosions for Annually Recurring Training Activities under Alternatives 1 and 2

Species	Behavioral Response	TTS	PTS	GI Tract Injury	Onset Slight Lung Injury	Onset Mortality
Mysticetes						
Blue Whale*	0	0	0	0	0	0
Bryde's Whale	0	0	0	0	0	0
Minke Whale	9	30	4	1	1	0
Fin Whale*	1	1	0	0	0	0
Humpback Whale*	0	1	0	0	0	0
North Atlantic Right Whale*	0	1	0	0	0	0
Sei Whale*	1	1	0	0	0	0
Odontocetes – Delphinids						
Atlantic Spotted Dolphin	15	34	3	0	9	3
Atlantic White-Sided Dolphin	4	7	1	0	2	1
Bottlenose Dolphin	27	45	3	1	4	2
Clymene Dolphin	1	2	0	0	1	0
Common Dolphin	19	41	3	0	14	5
False Killer Whale	0	0	0	0	0	0
Fraser's Dolphin	0	0	0	0	0	0
Killer Whale	0	1	0	0	0	0
Melon-Headed Whale	1	0	0	0	0	0
Pantropical Spotted Dolphin	2	4	0	0	1	0
Pilot Whale	6	12	1	0	2	1
Pygmy Killer Whale	0	0	0	0	0	0
Risso's Dolphin	8	14	1	0	2	1
Rough-Toothed Dolphin	0	0	0	0	0	0
Spinner Dolphin	1	1	0	0	0	0
Striped Dolphin	6	11	1	0	6	2
White-Beaked Dolphin	1	2	0	0	0	0
Odontocetes – Sperm Whale						
Sperm Whale*	1	1	0	0	0	0
Odontocetes – Beaked Whales						
Blainville's Beaked Whale	0	0	0	0	0	0
Cuvier's Beaked Whale	0	0	0	0	0	0
Gervais' Beaked Whale	0	0	0	0	0	0
Northern Bottlenose Whale	0	0	0	0	0	0
Sowerby's Beaked Whale	0	0	0	0	0	0
True's Beaked Whale	0	0	0	0	0	0
Odontocetes – *Kogia* Species and Porpoises						
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	1	5	2	0	0	0
Harbor Porpoise	94	497	177	1	21	2
Phocid Seals						
Gray Seal	0	0	0	0	0	0
Harbor Seal	1	2	0	0	0	0
Harp Seal	0	0	0	0	0	0

GI: gastrointestinal; PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA-listed species

Table 3.4-28: Predicted Impacts per Year from Explosions for Annually Recurring Testing Activities under the No Action Alternative

Species	Behavioral Response	TTS	PTS	GI Tract Injury	Onset Slight Lung Injury	Onset Mortality
Mysticetes						
Blue Whale*	0	0	0	0	0	0
Bryde's Whale	0	0	0	0	0	0
Minke Whale	2	5	1	0	0	0
Fin Whale*	0	0	0	0	0	0
Humpback Whale*	0	0	0	0	0	0
North Atlantic Right Whale*	0	0	0	0	0	0
Sei Whale*	0	0	0	0	0	0
Odontocetes – Delphinids						
Atlantic Spotted Dolphin	1	8	0	0	3	1
Atlantic White-Sided Dolphin	1	2	0	0	1	0
Bottlenose Dolphin	3	9	0	0	2	1
Clymene Dolphin	0	0	0	0	0	0
Common Dolphin	3	6	0	0	5	2
False Killer Whale	0	0	0	0	0	0
Fraser's Dolphin	0	0	0	0	0	0
Killer Whale	0	0	0	0	0	0
Melon-Headed Whale	0	0	0	0	0	0
Pantropical Spotted Dolphin	1	1	0	0	2	0
Pilot Whale	1	3	0	0	1	0
Pygmy Killer Whale	0	0	0	0	0	0
Risso's Dolphin	2	4	0	0	1	0
Rough-Toothed Dolphin	0	0	0	0	0	0
Spinner Dolphin	0	0	0	0	0	0
Striped Dolphin	2	2	0	0	3	1
White-Beaked Dolphin	0	0	0	0	0	0
Odontocetes –Sperm Whale						
Sperm Whale*	0	0	0	0	0	0
Odontocetes – Beaked Whales						
Blainville's Beaked Whale	0	0	0	0	0	0
Cuvier's Beaked Whale	0	0	0	0	0	0
Gervais' Beaked Whale	0	0	0	0	0	0
Northern Bottlenose Whale	0	0	0	0	0	0
Sowerby's Beaked Whale	0	0	0	0	0	0
True's Beaked Whale	0	0	0	0	0	0
Odontocetes – *Kogia* Species and Porpoises						
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	0	1	0	0	0	0
Harbor Porpoise	301	180	53	0	4	1
Phocid Seals						
Gray Seal	4	4	0	0	0	0
Harbor Seal	3	3	0	0	0	0
Harp Seal	1	1	0	0	0	0
Hooded Seal	0	0	0	0	0	0

GI: gastrointestinal; PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA-listed species

Table 3.4-29: Model-Predicted Impacts per Year from Explosions for Annually Recurring Testing Activities under Alternative 1

Species	Behavioral Response	TTS	PTS	GI Tract Injury	Onset Slight Lung Injury	Onset Mortality
Mysticetes						
Blue Whale*	0	0	0	0	0	0
Bryde's Whale	0	0	0	0	0	0
Minke Whale	3	9	1	0	0	0
Fin Whale*	0	0	0	0	0	0
Humpback Whale*	0	0	0	0	0	0
North Atlantic Right Whale*	0	0	0	0	0	0
Sei Whale*	0	1	0	0	0	0
Odontocetes – Delphinids						
Atlantic Spotted Dolphin	6	21	0	0	6	2
Atlantic White-Sided Dolphin	2	5	0	0	1	0
Bottlenose Dolphin	8	19	1	0	2	1
Clymene Dolphin	1	1	0	0	1	0
Common Dolphin	10	23	0	0	9	4
False Killer Whale	0	0	0	0	0	0
Fraser's Dolphin	0	0	0	0	0	0
Killer Whale	0	1	0	0	0	0
Melon-Headed Whale	0	1	0	0	0	0
Pantropical Spotted Dolphin	1	2	0	0	2	1
Pilot Whale	2	9	0	0	1	0
Pygmy Killer Whale	0	0	0	0	0	0
Risso's Dolphin	7	12	0	0	1	0
Rough-Toothed Dolphin	0	0	0	0	0	0
Spinner Dolphin	0	1	0	0	1	0
Striped Dolphin	6	10	0	0	5	1
White-Beaked Dolphin	0	1	0	0	0	0
Odontocetes – Sperm Whale						
Sperm Whale*	0	0	0	0	0	0
Odontocetes – Beaked Whales						
Blainville's Beaked Whale	0	0	0	0	0	0
Cuvier's Beaked Whale	0	0	0	0	0	0
Gervais' Beaked Whale	0	0	0	0	0	0
Northern Bottlenose Whale	0	0	0	0	0	0
Sowerby's Beaked Whale	0	0	0	0	0	0
True's Beaked Whale	0	0	0	0	0	0
Odontocetes – *Kogia* Species and Porpoises						
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	1	2	1	0	0	0
Harbor Porpoise	302	245	79	0	5	1
Phocid Seals						
Gray Seal	4	4	0	0	0	0
Harbor Seal	3	3	0	0	0	0
Harp Seal	1	1	0	0	0	0
Hooded Seal	0	0	0	0	0	0

GI: gastrointestinal; PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA-listed species

Table 3.4-30: Model-Predicted Impacts Per Year from Explosions for Annually Recurring Testing Activities under Alternative 2

Species	Behavioral Response	TTS	PTS	GI Tract Injury	Onset Slight Lung Injury	Onset Mortality
Mysticetes						
Blue Whale*	0	0	0	0	0	0
Bryde's Whale	0	0	0	0	0	0
Minke Whale	4	11	2	0	0	0
Fin Whale*	0	1	0	0	0	0
Humpback Whale*	0	0	0	0	0	0
North Atlantic Right Whale*	0	0	0	0	0	0
Sei Whale*	0	1	0	0	0	0
Odontocetes – Delphinids						
Atlantic Spotted Dolphin	7	24	0	0	7	2
Atlantic White-Sided Dolphin	2	6	0	0	1	1
Bottlenose Dolphin	10	23	1	0	3	1
Clymene Dolphin	1	1	0	0	1	0
Common Dolphin	12	28	0	0	12	4
False Killer Whale	0	0	0	0	0	0
Fraser's Dolphin	0	0	0	0	0	0
Killer Whale	0	1	0	0	0	0
Melon-Headed Whale	1	1	0	0	0	0
Pantropical Spotted Dolphin	2	2	0	0	4	1
Pilot Whale	3	11	0	0	1	0
Pygmy Killer Whale	0	0	0	0	0	0
Risso's Dolphin	8	14	0	0	2	0
Rough-Toothed Dolphin	0	0	0	0	0	0
Spinner Dolphin	0	1	0	0	1	0
Striped Dolphin	7	11	0	0	7	1
White-Beaked Dolphin	0	1	0	0	0	0
Odontocetes – Sperm Whales						
Sperm Whale*	1	0	0	0	0	0
Odontocetes – Beaked Whales						
Blainville's Beaked Whale	0	0	0	0	0	0
Cuvier's Beaked Whale	0	0	0	0	0	0
Gervais' Beaked Whale	0	0	0	0	0	0
Northern Bottlenose Whale	0	0	0	0	0	0
Sowerby's Beaked Whale	0	0	0	0	0	0
True's Beaked Whale	0	0	0	0	0	0
Odontocetes – *Kogia* Species and Porpoises						
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	1	2	1	0	0	0
Harbor Porpoise	485	348	110	0	7	1
Phocid Seals						
Gray Seal	6	6	1	0	0	0
Harbor Seal	6	6	1	0	0	0
Harp Seal	2	2	0	0	0	0
Hooded Seal	1	1	0	0	0	0

GI: gastrointestinal; PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA-listed species

Table 3.4-31: Predicted Impacts per Event from Explosions for Civilian Port Defense Occurring Biennially under Alternatives 1 and 2

Species	Behavioral Response	TTS	PTS	GI Tract Injury	Onset Slight Lung Injury	Onset Mortality
Mysticetes						
Blue Whale*	0	0	0	0	0	0
Bryde's Whale	0	0	0	0	0	0
Minke Whale	0	0	0	0	0	0
Fin Whale*	0	0	0	0	0	0
Humpback Whale*	0	0	0	0	0	0
North Atlantic Right Whale*	0	0	0	0	0	0
Sei Whale*	0	0	0	0	0	0
Odontocetes – Delphinids						
Atlantic Spotted Dolphin	0	0	0	0	0	0
Atlantic White-Sided Dolphin	0	0	0	0	0	0
Bottlenose Dolphin	0	0	0	0	0	0
Clymene Dolphin	0	0	0	0	0	0
Common Dolphin	0	0	0	0	0	0
False Killer Whale	0	0	0	0	0	0
Fraser's Dolphin	0	0	0	0	0	0
Killer Whale	0	0	0	0	0	0
Melon-Headed Whale	0	0	0	0	0	0
Pantropical Spotted Dolphin	0	0	0	0	0	0
Pilot Whale	0	0	0	0	0	0
Pygmy Killer Whale	0	0	0	0	0	0
Risso's Dolphin	0	0	0	0	0	0
Rough-Toothed Dolphin	0	0	0	0	0	0
Spinner Dolphin	0	0	0	0	0	0
Striped Dolphin	0	0	0	0	0	0
White-Beaked Dolphin	0	0	0	0	0	0
Odontocetes – Sperm Whale						
Sperm Whale*	0	0	0	0	0	0
Odontocetes – Beaked Whales						
Blainville's Beaked Whale	0	0	0	0	0	0
Cuvier's Beaked Whale	0	0	0	0	0	0
Gervais' Beaked Whale	0	0	0	0	0	0
Northern Bottlenose Whale	0	0	0	0	0	0
Sowerby's Beaked Whale	0	0	0	0	0	0
True's Beaked Whale	0	0	0	0	0	0
Odontocetes – *Kogia* Species and Porpoises						
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	0	0	0	0	0	0
Harbor Porpoise	0	7	1	0	0	0

GI: gastrointestinal; PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA-listed species

Table 3.4-32: Predicted Impacts for Aircraft Carrier Ship Shock Trials Occurring Once per Five-Year Period under Alternatives 1 and 2
(up to four 58,000-pound Net Explosive Weight Detonations)

Species	TTS	PTS	GI Tract Injury	Onset Slight Lung Injury	Onset Mortality
Mysticetes					
Blue Whale*	0	0	0	0	0
Bryde's Whale	0	0	0	0	0
Minke Whale	26	0	0	8	3
Fin Whale*	3	0	0	0	0
Humpback Whale*	1	0	0	0	0
North Atlantic Right Whale*	0	0	0	0	0
Sei Whale*	4	0	0	0	0
Odontocetes – Delphinids					
Atlantic Spotted Dolphin	1,098	0	0	1,683	109
Atlantic White-Sided Dolphin	123	0	0	116	30
Bottlenose Dolphin	175	0	0	95	26
Clymene Dolphin	0	0	0	73	11
Common Dolphin	1,449	0	0	1,955	106
False Killer Whale	0	0	0	0	0
Fraser's Dolphin	1	0	0	0	0
Killer Whale	2	0	0	2	0
Melon-Headed Whale	23	0	0	24	1
Pantropical Spotted Dolphin	40	0	0	57	5
Pilot Whale	87	0	0	140	22
Pygmy Killer Whale	3	0	0	3	0
Risso's Dolphin	52	0	0	46	14
Rough-Toothed Dolphin	1	0	0	0	0
Spinner Dolphin	15	0	0	23	2
Striped Dolphin	1,486	0	0	2,344	113
White-Beaked Dolphin	0	0	0	3	1
Odontocetes – Sperm Whale					
Sperm Whale*	11	0	0	3	2
Odontocetes – Beaked Whales					
Blainville's Beaked Whale	1	0	0	3	0
Cuvier's Beaked Whale	0	0	0	1	0
Gervais' Beaked Whale	1	0	0	4	0
Northern Bottlenose Whale	2	0	0	3	0
Sowerby's Beaked Whale	0	0	0	0	0
True's Beaked Whale	0	0	0	1	0
Odontocetes – *Kogia* Species and Porpoises					
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	3	1	0	3	0

GI: gastrointestinal; PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA-listed species

Table 3.4-33: Predicted Impacts per Event for the Guided Missile Destroyer and Littoral Combat Ship Shock Trials Occurring Three Times per Five-Year Period Under Alternatives 1 and 2
(up to four 14,500-pound Net Explosive Weight Detonations)

Species	TTS	PTS	GI Tract Injury	Onset Slight Lung Injury	Onset Mortality
Mysticetes					
Blue Whale*	0	0	0	0	0
Bryde's Whale	0	0	0	0	0
Minke Whale	5	0	0	1	0
Fin Whale*	1	0	0	0	0
Humpback Whale*	0	0	0	0	0
North Atlantic Right Whale*	0	0	0	0	0
Sei Whale*	1	0	0	0	0
Odontocetes – Delphinids					
Atlantic Spotted Dolphin	58	0	0	82	7
Atlantic White-Sided Dolphin	11	0	0	15	2
Bottlenose Dolphin	31	0	0	25	3
Clymene Dolphin	0	0	0	3	1
Common Dolphin	79	0	0	118	8
False Killer Whale	0	0	0	0	0
Fraser's Dolphin	0	0	0	0	0
Killer Whale	1	0	0	0	0
Melon-Headed Whale	2	0	0	2	0
Pantropical Spotted Dolphin	4	0	0	5	1
Pilot Whale	5	0	0	6	1
Pygmy Killer Whale	0	0	0	0	0
Risso's Dolphin	10	0	0	11	2
Rough-Toothed Dolphin	0	0	0	0	0
Spinner Dolphin	2	0	0	2	0
Striped Dolphin	74	0	0	124	4
White-Beaked Dolphin	0	0	0	0	0
Odontocetes – Sperm Whale					
Sperm Whale*	3	0	0	1	0
Odontocetes – Beaked Whales					
Blainville's Beaked Whale	0	0	0	0	0
Cuvier's Beaked Whale	0	0	0	0	0
Gervais' Beaked Whale	0	0	0	0	0
Northern Bottlenose Whale	1	0	0	1	0
Sowerby's Beaked Whale	0	0	0	0	0
True's Beaked Whale	0	0	0	0	0
Odontocetes – *Kogia* Species and Porpoises					
Dwarf and Pygmy Sperm Whales (*Kogia* spp.)	1	0	0	0	0

GI: gastrointestinal; PTS: permanent threshold shift; TTS: temporary threshold shift
* ESA

could be predicted to receive more than one acoustic impact over the course of a year. Species presented in tables had species density values (i.e., theoretically present to some degree) within the areas modeled for the given alternative and activities, although all predicted effects may still indicate "0" (zero) after summing all impacts and applying standard arithmetic rounding rules (i.e., numbers less than 0.5 round down to 0.0).

3.4.3.1.9.4 No Action Alternative – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.2 (Explosives), training activities under the No Action Alternative would use underwater detonations and explosive munitions. Training activities involving explosions would be conducted throughout the Study Area but would be concentrated in the VACAPES Range Complex, followed in descending order of numbers of activities by JAX, Navy Cherry Point, GOMEX, and the Northeast Range Complexes. These events would be concentrated in the Northeast U.S. Continental Shelf and Southeast U.S. Continental Shelf Large Marine Ecosystems or the Gulf Stream Open Ocean Area, with fewer activities in the Gulf of Mexico Large Marine Ecosystem and the North Atlantic Gyre Open Ocean Area. Activities that involve underwater detonations and explosive munitions typically occur more than 3 nm from shore.

Predicted effects on marine mammals from exposures to explosions during annually recurring training activities under the No Action Alternative are shown in Table 3.4-22. Civilian port defense training activities would not take place under the No Action Alternative. About 15 percent of modeled activities involve multiple detonations (multiple detonations, as defined for this analysis, are described in Section 3.4.3.1.4.5, Behavioral Responses) and are therefore evaluated for potential behavioral responses from marine mammals.

Mysticetes

Predicted impacts on mysticetes from training activities under the No Action Alternative from explosions are relatively low over a year of training activities, with 1 PTS, 10 TTS, and 3 behavioral responses predicted. The acoustic analysis predicts that two species, the minke and sei whale, could potentially be impacted, although all mysticetes within the Study Area could be exposed to sound and energy from explosions. Table 3.4-18 presents predicted ranges to specified effects for low-frequency cetaceans (mysticetes). Impacts are predicted primarily within VACAPES, JAX, and Navy Cherry Point Range Complexes, in the Northeast U.S. Continental Shelf and Southeast U.S. Continental Shelf Large Marine Ecosystems, and the Gulf Stream Open Ocean Area.

North Atlantic Right Whales (ESA-Listed)

North Atlantic right whales may be exposed to sound or energy from explosions associated with training activities throughout the year, although acoustic modeling predicts no impacts on North Atlantic right whales. Although ESA-listed North Atlantic right whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of training, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Training activities that use explosives, with the exception of training with explosive sonobuoys, are not conducted in the southeast North Atlantic right whale mitigation area. Training activities that use explosives would not occur in the northeast North Atlantic right whale mitigation area. The sound and energy from explosions associated with training activities under the No Action Alternative would not impact the assumed primary constituent elements of the southeast North Atlantic right whale critical habitat (i.e., water temperature and depth).

Humpback Whales (ESA-Listed)

Humpback whales may be exposed to sound or energy from explosions associated with training activities throughout the year, although the acoustic analysis predicts that no humpback whales would be impacted. Although ESA-listed humpback whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of training, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Sei Whales (ESA-Listed)

Sei whales may be exposed to sound and energy from explosions associated with training activities throughout the year. The acoustic analysis predicts that one sei whale could be exposed annually to sound from explosions that may cause TTS. This could happen anywhere within the Study Area. Predicted impacts would be to the Nova Scotia stock since this is the only sei whale stock present within the Study Area.

Animals that do experience TTS may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations until their hearing recovers. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. Considering these factors and the low number of overall predicted impacts, long-term consequences for individuals or populations would not be expected.

Fin Whales (ESA-Listed)

Fin whales may be exposed to sound or energy from explosions associated with training activities throughout the year, although the acoustic analysis predicts that no fin whales would be impacted. Although ESA-listed fin whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of training, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Blue Whales (ESA-Listed)

Blue whales may be exposed to sound or energy from explosions associated with training activities throughout the year, although the acoustic analysis predicts that no blue whales would be impacted. Although ESA-listed blue whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of training, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Minke and Bryde's Whales

Minke and Bryde's whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The acoustic analysis predicted no impacts on Bryde's whales from training activities involving explosions. The acoustic analysis predicts that minke whales could be exposed to sound annually that may result in 3 behavioral reactions, 9 TTS, and 1 PTS (Table 3.4-22 describes the predicted numbers of exposures). As with mysticetes overall, impacts are primarily predicted within the VACAPES Range Complex, followed by JAX, Navy Cherry Point, and GOMEX Range Complexes. All predicted impacts on minke whales would be to the Canadian East Coast stock since this is the only stock present within the Study Area.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that if mysticetes are exposed to the sound from explosions, they may react in a variety of ways, which may include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, or showing no response at all. Occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences for individual mysticetes or populations.

Animals that do experience TTS may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations until their hearing recovers. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age. Considering these factors and the low number of overall predicted impacts, consequences for individuals or populations would not be expected.

<u>Odontocetes</u>

Sperm Whales (ESA-Listed)

Sperm whales may be exposed to sound and energy from explosions associated with training activities throughout the year; however, the acoustic analysis predicts that no sperm whales would be impacted. Although ESA-listed sperm whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of training, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and

Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Dolphins and Small Whales (Delphinids)

Dolphins and small whales (delphinids) may be exposed to sound and energy from explosions associated with training activities throughout the year. The acoustic analysis predicts that delphinids could be exposed to sound that may result in mortality, injury, temporary hearing loss, and behavioral reactions (Table 3.4-22 describes predicted numbers of exposures). The majority of these exposures occur within the VACAPES and GOMEX Range Complexes. Most delphinid species are separated into two stocks within the Study Area: the Western North Atlantic and Gulf of Mexico. Predicted impacts on delphinids within the Gulf of Mexico are presumed to primarily impact the Gulf of Mexico stocks, whereas the majority of impacts predicted offshore of the east coast would impact the Western North Atlantic stocks. Bottlenose dolphins are divided into multiple coastal and one oceanic stock along the east coast. The majority of exposures to bottlenose dolphins from training activities involving explosives would be to the oceanic stock.

A total of 12 onset mortalities and 36 onset slight lung injuries are predicted for the following delphinids: Atlantic spotted dolphins, Atlantic white-sided dolphins, bottlenose dolphins, clymene dolphins, common dolphins, pantropical spotted dolphins, pilot whales, Risso's dolphins, spinner dolphins, and striped dolphins. These explosive impact criteria are based upon newborn calf weights, and therefore these effects are overpredicted by the model, assuming most animals within the population are larger than a newborn calf. Furthermore, as explained above, the criteria for mortality and slight lung injury are very conservative (e.g., overestimate the effect). Nevertheless, it is possible for delphinids to be injured or killed by an explosion in isolated instances. While the Navy does not anticipate delphinid mortalities from underwater detonations during mine neutralization activities involving time-delay diver placed charges, there is a possibility of a marine mammal approaching too close to an underwater detonation when there is insufficient time to delay or stop without jeopardizing human safety. Considering that delphinid species for which these impacts are predicted have stocks with tens of thousands of animals, removing several animals from the population would be unlikely to have measurable long-term consequences.

A total of 3 PTS and 65 TTS are predicted for 11 species of delphinids. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age.

The acoustic analysis indicates that 58 delphinids from 11 species could be exposed to sound or energy from underwater explosions that would result in a behavioral response. Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that if delphinids are exposed to explosions, they may react by alerting, ignoring the stimulus, changing their behaviors or vocalizations, or avoiding the area by swimming away or diving. Overall, predicted impacts are low. Occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences for individual animals or populations.

Beaked Whales

Beaked whales may be exposed to sound and energy from explosions associated with training activities throughout the year, although the acoustic analysis predicts that no beaked whales would be impacted. Long-term consequences for individuals or populations would not be expected.

Pygmy and Dwarf Sperm Whales (*Kogia* spp.)

Pygmy and dwarf sperm whales (genus: *Kogia*) may be exposed to sound and energy from explosions associated with training activities throughout the year. The acoustic analysis predicts that pygmy and dwarf sperm whales could be exposed to sound annually that may result in three TTS and one PTS (Table 3.4-22 describes predicted numbers of exposures). The majority of these exposures occur within the VACAPES and GOMEX Range Complexes. *Kogia* species are separated into two stocks within the Study Area: the Western North Atlantic and Gulf of Mexico Oceanic. Predicted impacts on pygmy and dwarf sperm whales within the Gulf of Mexico are presumed to primarily impact the Gulf of Mexico stocks, whereas the majority of impacts predicted offshore of the east coast would impact the Western North Atlantic stocks.

Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age. Long-term consequences for the population would not be expected.

Harbor Porpoises

Harbor porpoises may be exposed to sound and energy from explosions associated with training activities throughout the year. The acoustic analysis predicts that harbor porpoises could be exposed to sound that may result in 9 behavioral reactions, 120 TTS, 53 PTS, 3 slight lung injuries, and 1 mortality (Table 3.4-22 describes predicted numbers of exposures). Predicted impacts on this species are in the VACAPES Range Complex, generally within the Northeast U.S. Continental Shelf Large Marine Ecosystem. All harbor porpoises within the Study Area belong to the Gulf of Maine/Bay of Fundy Stock, and therefore all predicted impacts would be incurred to this stock.

Onset mortality and onset slight lung injury criteria use conservative thresholds to predict the onset of effect as discussed in Section 3.4.3.1.4 (Thresholds and Criteria for Predicting Acoustic and Explosive Impacts on Marine Mammals). The thresholds are based upon newborn calf masses, and therefore these impacts are overpredicted by the acoustic model, assuming most animals within the population are larger than a newborn calf. As explained above, the criteria for onset mortality and onset slight lung injury are very conservative (e.g., overestimate the effect). Furthermore, harbor porpoises are wary of human activity and may avoid the area around the detonation point before the explosion occurs due to activity associated with setting up underwater detonations or targets. Nevertheless, it is possible for harbor porpoises to be injured or killed by an explosion. Considering that harbor porpoises are numerous, measurable population level effects are unlikely even upon removing a few animals from the population.

Animals that do experience hearing loss (PTS or TTS) may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age. Long-term consequences for the population would not be expected.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) of harbor porpoises show that this small species is wary of human activity and will avoid anthropogenic sound sources in many situations at levels down to 120 dB re 1 µPa. Harbor porpoises may startle and leave the immediate area of the training exercise but return within a few days after the event ends. As discussed above, harbor porpoises may leave the area before a detonation, allowing the animal to avoid more significant impacts such as hearing loss, injury, or mortality. Significant behavioral reactions seem more likely than with most other odontocetes. Animals that do exhibit a significant behavioral reaction would likely recover from any incurred costs, reducing the likelihood of long-term consequences for the individual or population.

Phocid Seals

Phocid seals may be exposed to sound and energy from explosions associated with training activities throughout the year, although the acoustic analysis predicts that no phocid seals would be impacted. Long-term consequences for individuals or populations would not be expected.

Manatees (ESA-Listed)

The manatee is primarily an inshore species, with most sightings occurring in warm fresh water, estuaries, and occasionally extremely nearshore coastal waters. Training activities that include explosions do not typically occur within or near West Indian manatee habitat, and therefore, impacts on manatees are unlikely. For this reason, manatees were not considered within the acoustic model when predicting impacts from explosions associated with the Proposed Action. Proposed activities involving explosions would not take place within or near ESA-designated critical habitat and therefore would not affect it.

Conclusion

Training activities under the No Action Alternative include the use of explosions as described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-1, and in Section 3.0.5.3.1.2 (Explosives). These activities do not overlap bowhead whale, beluga whale, narwhal, walrus, or polar bear habitat. Therefore, it is very unlikely that these marine mammal species would be exposed to noise or energy from explosions.

It is important to note, as discussed in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), that there are additional protections offered by mitigation measures (as described in detail in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) which will further reduce potential impacts to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects.

Pursuant to the MMPA, the use of explosive sources during training activities as described under the No Action Alternative:

- *may expose marine mammals up to 268 times annually to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to 97 times annually to sound or energy levels that would be considered Level A harassment; and*
- *may expose up to 13 marine mammals annually to explosive energy that may cause mortality.*

Table 3.4-22 presents the Navy's marine mammal predicted exposures for Training Activities under the No Action Alternative.

Pursuant to the ESA, the use of explosive sources during training activities as described under the No Action Alternative:

- *may affect and is likely to adversely affect the sei whale;*
- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, polar bear, and West Indian manatee; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.9.5 No Action Alternative – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-2 and Table 2.8-3, and Section 3.0.5.3.1.2 (Explosives), testing activities under the No Action Alternative would use underwater detonations and explosive munitions. Testing activities involving explosions could be conducted throughout the Study Area but would be concentrated in the VACAPES Range Complex, followed by the JAX and Key West Range Complexes. These events would be concentrated in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Caribbean Sea Large Marine Ecosystems and the Gulf Stream Open Ocean Area. Testing activities using explosions do not normally occur within 3 nm of shore; the exception is the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is nearshore, partially within the surf zone.

Predicted acoustic impacts on marine mammals from exposure to explosions during annually recurring testing activities under the No Action Alternative are shown in Table 3.4-24. Aircraft carrier sea trials and ship shock trials would not occur under the No Action Alternative. Approximately 15 percent of modeled activities involve multiple detonations (multiple detonations, as defined for this analysis, are described in Section 3.4.3.1.4.5, Behavioral Responses) and are therefore evaluated for potential behavioral responses from marine mammals.

<u>Mysticetes</u>

Overall predicted impacts on mysticetes from explosions used during testing activities under the No Action Alternative are relatively low. The acoustic analysis predicts that only the minke whale would potentially be impacted, although all mysticetes within the Study Area could be exposed to sound and energy from explosions. Section 3.4.3.1.9.1 (Range to Effects) discusses predicted ranges to specific impacts for low-frequency cetaceans (mysticetes). Impacts are predicted primarily within the Naval

Surface Warfare Center, Panama City Division Testing Range in the Gulf of Mexico Large Marine Ecosystem and in the VACAPES Range Complex within the Northeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area.

North Atlantic Right Whales (ESA-Listed)

North Atlantic right whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts no impacts on North Atlantic right whales. Although ESA-listed North Atlantic right whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of testing, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Testing activities that use explosives would not occur in the North Atlantic right whale mitigation areas. The sound and energy from explosions associated with testing activities under the No Action Alternative would not impact the assumed primary constituent elements of the North Atlantic right whale critical habitats (i.e., water temperature and depth in the southeast and copepods in the northeast).

Humpback Whales (ESA-Listed)

Humpback whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts that no humpback whales would be impacted. Although ESA-listed humpback whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of testing, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Sei Whales (ESA-Listed)

Sei whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts that no sei whales would be impacted. Although ESA-listed sei whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of testing, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Fin Whales (ESA-Listed)

Fin whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts that no fin whales would be impacted.

Although ESA-listed fin whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of testing, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Blue Whales (ESA-Listed)

Blue whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts that no blue whales would be impacted. Although ESA-listed blue whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of testing, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Minke and Bryde's Whales

Minke and Bryde's whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The acoustic analysis predicted no impacts to Bryde's whale from testing activities involving explosions. The acoustic analysis predicts that minke whales could be exposed to sound and energy from explosives annually that may result in two behavioral responses, five TTS, and one PTS. All predicted effects on minke whales would be to the Canadian East Coast stock since this is the only stock present within the Study Area.

Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that if mysticetes are exposed to explosions, they may react in a variety of ways, which may include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, or showing no response at all. Occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences for individual mysticetes or populations.

Odontocetes

Sperm Whales (ESA-Listed)

Sperm whales may be exposed to sound and energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts that no sperm whales would be impacted. Although ESA-listed sperm whales are present in the Study Area, it is unlikely that explosive stressors and this species would co-occur based on the expected locations of testing, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. Even with use of conservative assumptions in the acoustic impacts modeling, criteria, and thresholds (see Section 3.4.3.1.5.4, Model Assumptions and Limitations, and Section 3.4.3.1.10.3, Predicted Impacts), the quantitative analysis of acoustic impacts predicts that this species is unlikely to be affected by the use of explosives. Long-term consequences for individuals or populations would not be expected.

Dolphins and Small Whales (Delphinids)

Dolphins and small whales (delphinids) may be exposed to sound and energy from explosions associated with testing activities throughout the year. The acoustic analysis predicts that delphinids could be exposed to sound that may result in 5 mortalities, 18 slight lung injuries, 35 TTS, and 14 behavioral reactions (Table 3.4-24 describes predicted numbers of exposures). Predicted explosive impacts on dolphins occur primarily in the VACAPES Range Complex and the Naval Surface Warfare Center, Panama City Division Testing Range, but a few impacts could occur throughout the Study Area. Impacts would be concentrated within the Northeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems, and the Gulf Stream Open Ocean Area. Most dolphin species are separated into two stocks within the Study Area: the Western North Atlantic and Gulf of Mexico. Predicted impacts on delphinids within the Gulf of Mexico are presumed to be on the Gulf of Mexico stocks, whereas the majority of impacts predicted offshore of the east coast would be on the Western North Atlantic stocks. Bottlenose dolphins are divided into multiple coastal and one oceanic stock along the east coast. The majority of exposures to bottlenose dolphins are likely to the oceanic stock.

Mortality and slight lung injury are predicted for eight species of dolphins, including Atlantic spotted dolphins, Atlantic white-sided dolphins, bottlenose dolphins, common dolphins, pantropical spotted dolphins, pilot whales, Risso's dolphins, and striped dolphins. These explosive criteria are based upon newborn calf weights, and therefore these effects are overpredicted by the model, assuming most animals within the population are larger than a newborn calf. Furthermore, as explained above, the criteria for mortality and slight lung injury are very conservative (e.g., overestimate the effect). Nevertheless, it is possible for delphinids to be injured or killed by an explosion in isolated instances. Considering that delphinid species for which these effects are predicted have stocks with tens of thousands of animals, removing several animals from the population would be unlikely to have measurable long-term consequences.

Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that if delphinids are exposed to explosions, they may react by alerting, ignoring the stimulus, changing their behaviors or vocalizations, or avoiding the area by swimming away or diving. Overall, predicted effects are low. Occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences for individual animals or populations.

Beaked Whales

Beaked whales may be exposed to sound and energy from explosions associated with testing activities throughout the year, although the acoustic analysis predicts that no beaked whales would be impacted. Long-term consequences for individuals or populations would not be expected.

Pygmy and Dwarf Sperm Whales (*Kogia* spp.)

Pygmy and dwarf sperm whales may be exposed to sound and energy from explosions associated with testing activities throughout the year. The acoustic analysis predicts that a pygmy or dwarf sperm whale could be exposed to energy or sound from underwater explosions that may result in one TTS. This impact could happen anywhere throughout the Study Area where testing activities involving explosives occur.

Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age.

Harbor Porpoises

Harbor porpoises may be exposed to sound and energy from explosions associated with testing activities throughout the year. The acoustic analysis predicts that harbor porpoises could be exposed to sound that may result in 301 behavioral reactions, 180 TTS, 53 PTS, 4 slight lung injuries, and 1 mortality. Predicted impacts on this species are primarily within the VACAPES and Northeast Range Complexes. Impacts would primarily occur within the Northeast U.S. Continental Shelf Large Marine Ecosystem. All harbor porpoises within the Study Area belong to the Gulf of Maine/Bay of Fundy stock, and therefore, all predicted impacts would be on this stock.

Onset mortality and onset slight lung injury criteria are based upon newborn calf masses, and therefore these effects are overpredicted by the acoustic model, assuming most animals within the population are larger than a newborn calf. As explained above, the criteria for onset mortality and onset slight lung injury are very conservative (e.g., overestimate the effect). Furthermore, harbor porpoises are wary of human activity and may avoid the area around the detonation point before the explosion occurs due to activity associated with setting up underwater detonations or targets. Nevertheless, it is possible for harbor porpoises to be injured or killed by an explosion. Considering that harbor porpoises are numerous, measureable population level effects are unlikely even upon removing a few animals from the population.

PTS and TTS are predicted for harbor porpoises. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days depending on the severity of the initial shift. PTS would not fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. It is uncertain whether some permanent hearing loss over a part of a marine mammal's hearing range would have long-term consequences for that individual, although many mammals lose hearing ability as they age.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) of harbor porpoises show that this species is wary of human activity and will avoid anthropogenic sound sources, in many situations at levels down to 120 dB re 1 μPa. Harbor porpoises may startle and leave the immediate area of the testing exercise but return within a few days after the event ends. Animals may also leave the area before an event begins, based on activity related to underwater detonation placement or target area setup. Therefore, these animals could avoid more significant impacts such as hearing loss, injury, or mortality. Significant behavioral reactions are more likely than with most other marine mammals. Animals that do exhibit a significant behavioral reaction would likely recover from any incurred cost, reducing the likelihood of long-term consequences for the individual. Any long-term consequences, such as reduced fitness to a few individuals, are unlikely to cause long-term consequences for harbor porpoise populations.

Phocid Seals

Phocid seals may be exposed to sound and energy from explosions associated with testing activities throughout the year. The acoustic analysis predicts that phocid seals could be exposed to sound that may result in eight behavioral reactions and eight TTS. The predicted effects are in the Northeast Range Complexes within the Northeast U.S. Continental Shelf Large Marine Ecosystem.

Animals that do experience TTS may have reduced ability to detect relevant sounds such as predators, prey, or social vocalizations until their hearing recovers. Recovery from a threshold shift (i.e., partial hearing loss) can take a few minutes to a few days, depending on the severity of the initial shift. Threshold shifts do not necessarily affect all hearing frequencies equally, so some threshold shifts may not interfere with an animal hearing biologically relevant sounds. Considering these factors and the low number of overall predicted impacts, long-term consequences for individuals or populations would not be expected.

Research and observations (Section 3.4.3.1.2.5, Behavioral Reactions) show that pinnipeds in the water are tolerant of anthropogenic noise and activity. Significant behavioral reactions would not be expected in most cases. Overall, predicted effects are low. Occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences for individual animals or populations.

Manatees (ESA-Listed)

The manatee is primarily an inshore species, with most sightings occurring in warm fresh water, estuaries, and occasionally extremely nearshore coastal waters. Testing activities that include explosions do not typically occur in West Indian manatee habitat, and therefore, impacts on manatees are unlikely. Proposed activities involving explosions would not take place within ESA-designated critical habitat. There were no model-predicted effects to manatees from explosions associated with the Proposed Action, however, within the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is nearshore and partially within the surf zone, manatees could be exposed to sound and energy from underwater explosions. Mitigation measures outlined in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) would reduce or eliminate the potential for manatees to be exposed to high levels of explosive sound and energy that could cause injury or strong behavioral reactions.

Conclusion

Testing activities under the No Action Alternative include the use of explosions as described in Table 2.8-2 and Table 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives) and in Section 3.0.5.3.1.2 (Explosives). These activities do not overlap bowhead whale, beluga whale, narwhal, walrus, or polar bear habitat. Therefore, it is very unlikely that these marine mammal species would be exposed to noise or energy from explosions.

It is important to note, as discussed in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), that there are additional protections offered by mitigation measures (as described in detail in Chapter 5; Standard Operating Procedures, Mitigation, and Monitoring) which will further reduce potential impacts to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects. Pursuant to the MMPA, the use of explosive sources during testing activities as described under the No Action Alternative:

- *may expose marine mammals up to 554 times annually to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to 76 times annually to sound or energy levels that would be considered Level A harassment; and*
- *may expose up to 6 marine mammals annually to explosive energy that may cause mortality.*

Table 3.4-24 presents the Navy's marine mammal predicted exposures for Testing Activities under the No Action Alternative.

Pursuant to the ESA, the use of explosive sources during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, fin whale, sei whale, blue whale, sperm whale and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.9.6 Alternative 1 – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.2 (Explosives), the number of annual training activities that use explosives under Alternative 1 would approximately double (Section 3.4.3.1.9.4, No Action Alternative – Training Activities, describes predicted impacts on marine mammals under the No Action Alternative). For Alternative 1, predicted effects are shown in Table 3.4-23 for annually recurring training activities and in Table 3.4-27 for civilian port defense. These activities would happen in the same general locations and in similar numbers as described by the No Action Alternative, with the following notable exceptions:

- Training activities using explosive source sonobuoys (Bin E4) would be relocated from the GOMEX Range Complex under Alternative 1 to the VACAPES and JAX Range Complexes. This would decrease impacts in the GOMEX Range Complex and increase impacts for the VACAPES and JAX Range Complexes.
- Alternative 1 would include the training activity civilian port defense, which is not included under the No Action Alternative. Table 3.4-27 indicates that predicted effects on marine mammals are very low. This event would take place once every two years in one of the following locations: Earle, New Jersey; Groton, Connecticut; Hampton Roads, Virginia; Morehead City, North Carolina; Wilmington, North Carolina; Kings Bay, Georgia; Mayport, Florida; Beaumont, Texas; or Corpus Christi, Texas. However, any phases of the event that involve underwater detonation training would occur in designated areas in the VACAPES, JAX, and GOMEX Range Complexes. Predicted impacts represent the highest estimate of impacts on each species across all areas. Throughout all of the areas and seasons, only harbor porpoises in the winter in the VACAPES Range Complex were predicted to receive seven TTS and one PTS.

- Two additional joint task force/sustainment exercises per year (four total) are proposed under Alternative 1. There are no predicted impacts on marine mammals from these events.
- Mine neutralization events would increase in the VACAPES Range Complex under Alternative 1 to 524 events per year from 24 events per year, as described under the No Action Alternative. These activities use up to a 60 lb. net explosive weight charge (but typically use a 20 lb. net explosive weight charge or less) to destroy an underwater mine (explosive mines are not used for this activity, only mine-like shapes). Predicted impacts would increase substantially due to the increase in this activity. Model predicted impacts indicate behavioral reactions, TTS, slight lung injuries, and mortalities for several dolphin species; and 2 behavioral reactions, 6 TTS, and one PTS of minke whales not predicted under the No Action Alternative. Total predicted impacts on harbor porpoises from mine neutralization activities increased from 14 to 278.

The increase in proposed activities under Alternative 1 over the No Action Alternative would in turn lead to an overall increase in predicted impacts on marine mammals by a factor of about three (behavioral reactions, TTS, PTS, gastrointestinal tract injuries, slight lung injuries, and mortalities). This could mean an increase in the number of individual animals exposed per year or an increase in the number of times per year some animals are exposed, although the types and severity of individual responses to explosions are unlikely to change. Notable results from Alternative 1 are as follows:

- Predicted impacts on mysticetes would increase by a factor of approximately three times. Predicted impacts on minke whales would include 9 behavioral reactions, 30 TTS, 4 PTS, 1 gastrointestinal tract injury, and 1 slight lung injury. For ESA-listed mysticetes, Alternative 1 also includes one behavioral reaction and one TTS prediction each for fin and sei whales, one TTS for a humpback whale, and one TTS for a North Atlantic right whale.
- Predicted impacts on ESA-listed sperm whales would increase under Alternative 1, to include one behavioral reaction and one TTS.
- Predicted impacts on delphinids would increase by about 90 percent.
- As with the No Action Alternative, there are no predicted impacts on beaked whales.
- Predicted impacts on harbor porpoises would increase by a factor of approximately four times due primarily to an increase in mine neutralization, bombing, and naval gunnery training exercises in the VACAPES Range Complex. Predicted behavioral reactions, TTS, and PTS would increase, as would the predicted numbers of mortalities and lung injuries.
- Predicted impacts on pygmy and dwarf sperm whales would be minor overall and would not substantially change from the No Action Alternative.
- Predicted impacts on phocids would increase slightly, including two TTS and one behavioral reaction for harbor seals.
- As with the No Action Alternative, training activities that include explosions would not typically occur in West Indian manatee habitat, so impacts on manatees from explosive sources were not quantitatively analyzed. Activities would not affect West Indian manatee critical habitat.

Although impacts on marine mammals due to explosive energy and sound would increase under Alternative 1 compared to the No Action Alternative, the types and severity of individual responses to explosions are unlikely to change. Increases in the number of times individual animals are exposed throughout the year could occur, which would increase the likelihood of that individual suffering long-term consequences due to repeated exposures. The number of animals exposed throughout the year could also increase, although it is uncertain how the increase in the number of individual animals predicted to receive direct impacts, and therefore the number of individuals that may suffer long-term consequences, would affect populations.

As described under the No Action Alternative, mortalities and lung injuries are overpredicted; hearing loss may affect an animal's ability to detect relevant sounds for a short period or permanently depending on the level of exposure; and behavioral reactions could occur, although occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences. If long-term consequences for a few animals in populations that number in the tens of thousands do occur, they are unlikely to have measurable long-term consequences for marine mammal populations.

It is important to note, as discussed in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), that there are additional protections offered by mitigation measures (as described in detail in Chapter 5; Standard Operating Procedures, Mitigation, and Monitoring) which will further reduce potential impacts to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects. Pursuant to the MMPA, the use of explosive sources during training activities as described under Alternative 1:

- *may expose marine mammals up to 912 times annually to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to 262 times annually to sound or energy levels that would be considered Level A harassment;*
- *may expose marine mammals up to 7 times during each biennial civilian port defense activity to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to one time during each biennial civilian port defense activity to sound or energy levels that would be considered Level A harassment; and*
- *may expose up to 17 marine mammals annually to explosive energy that may cause mortality.*

Table 3.4-23 and Table 3.4-27 present the Navy's marine mammal predicted exposures for training activities under Alternative 1.

Pursuant to the ESA, the use of explosive sources during training activities as described under Alternative 1:

- *may affect and is likely to adversely affect the ESA-listed sperm whale, sei whale, fin whale, humpback whale, and North Atlantic right whale;*
- *may affect but is not likely to adversely affect the ESA-listed blue whale;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, polar bear, and West Indian manatee; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.9.7 Alternative 1 – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-2 and Table 2.8-3, and in Section 3.0.5.3.1.2 (Explosives), the number of annual testing activities that use explosions under Alternative 1 would increase over the No Action Alternative. These activities would happen in the same general locations under Alternative 1 as under the No Action Alternative. New testing activities proposed under Alternative 1 and notable increases in numbers of activities from the No Action Alternative are as follows:

- Alternative 1 would include one aircraft carrier sea trial, which would take place once within a five-year period. This event could take place during any season; however, there are no predicted impacts to marine mammals from energy or sound associated with underwater explosions.

- Alternative 1 would include one aircraft carrier ship shock trial during the five-year period. This event could take place in one of two locations (VACAPES or JAX Range Complex) during fall, winter, or summer. Predicted impacts represent the highest estimate for each species across all areas and seasons. The aircraft carrier ship shock trial would use up to four 58,000 lb. net explosive weight charges, one at a time, over a several-week period. Predicted impacts from the aircraft carrier shock trial are substantial (see Table 3.4-28). They include 4,607 TTS, 1 PTS, 6,590 slight lung injuries, and 445 mortalities of marine mammals. Impacts are predicted mostly for dolphin species, although 4 TTS are predicted for the ESA-listed sei whale, 1 TTS for the ESA-listed humpback whale, and 3 TTS for the ESA-listed fin whale. Additionally, the acoustic analysis predicts 11 TTS, 3 slight lung injuries, and 2 mortalities for the ESA-listed sperm whale. For non-ESA listed species, all mortalities are predicted to be delphinids, with the exception that three minke whale mortalities. Based on conservativeness of the onset mortality criteria and impulse modeling, and past ship shock trials during which no marine mammal mortalities were observed, the mortalities predicted for the aircraft carrier ship shock trial are considered overestimates and highly unlikely to occur. Therefore, the Navy conservatively estimates that 10 small odontocete mortalities could occur during the aircraft carrier ship shock trial. Although shipboard and aerial pre-exercise monitoring to avoid exposing marine mammals to high levels of explosive energy were applied to the model-predicted mortalities for aircraft carrier shock trials, it is important to note that there are additional protections offered by mitigation measures, which are known to be effective and will reduce exposures to marine mammals, but are not considered in the quantitative adjustment of the tabulated impacts.
- Alternative 1 would include one guided missile destroyer ship shock trial and two Littoral Combat Ship shock trials during the five-year period. These ship shock trials would use up to four 14,500 lb. net explosive weight charges, one at a time, over a several week period. These events could take place in the JAX Range Complex during fall, spring, or summer, or year-round within the VACAPES Range Complex. Predicted impacts represent the highest estimate for each species across all areas and seasons. Predicted impacts are substantial (Table 3.4-29) and include 289 TTS, 396 slight lung injuries, and 29 mortalities per event, mostly to delphinid species. The acoustic analysis predicts one TTS for the ESA-listed sei whale and one TTS for the ESA-listed fin whale. Predicted impacts include three TTS and one slight lung injury for the ESA-listed sperm whale per event. Based on conservativeness of the onset mortality criteria and impulse modeling, and past ship shock trials during which no marine mammal mortalities were observed, the mortalities predicted for the these ship shock trials are considered overestimates and highly unlikely to occur. Therefore, the Navy conservatively estimates that 15 small odontocete mortalities could occur during these three ship shock trials. Although pre-exercise monitoring to avoid exposing marine mammals to high levels of explosive energy was applied to the model-predicted mortalities for these shock trials, it is important to note that there are additional protections offered by mitigation measures, which are known to be effective and will reduce exposures to marine mammals, but are not considered in the quantitative adjustment of the tabulated impacts.

The increase in proposed annual testing activities under Alternative 1 over the No Action Alternative would increase overall predicted impacts on marine mammals (behavioral reactions, hearing loss, injuries, and mortalities) by 44 percent, in addition to the predicted impacts due to the proposed ship shock trials. This could mean an increase in the number of individual animals exposed per year or an increase in the number of times per year some animals are exposed, although the types and severity of individual responses to explosions are unlikely to change. Predicted acoustic impacts on marine mammals from exposure to explosions from annually recurring testing activities under Alternative 1 are shown in Table 3.4-25, for aircraft carrier shock trials in Table 3.4-28, and for guided missile destroyer and Littoral Combat Ship shock trials in Table 3.4-29. Notable results for Alternative 1 are as follows:

- Predicted impacts on mysticetes would increase. Predicted impacts on minke whales could increase during annually recurring activities as well as due to the addition of ship shock trials. In addition to the predicted impacts on ESA-listed mysticetes due to ship shock trials (discussed above), one TTS for a sei whale is predicted per year due to annual testing activities.
- Predicted impacts on ESA-listed sperm whales would increase primarily due to the inclusion of ship shock trials. See above discussions on shock trials for details.
- Predicted impacts on delphinids would increase by 151 percent due to increases in annually recurring testing activities. Shock trials could also impact up to 13,656 delphinids per five-year period. See above discussions on shock trials for details.
- As with testing activities under the No Action Alternative, there are no predicted explosive impacts on beaked whales due to annually recurring testing activities under Alternative 1. Ship shock trials are predicted to impact 22 beaked whales (7 behavioral harassments and 15 injuries) over five years.
- Predicted impacts from annual testing activities to harbor porpoises would increase by 17 percent. No impacts to harbor porpoises are predicted due to shock trials.
- Predicted impacts on pygmy and dwarf sperm whales would slightly increase. Additionally, ship shock trials could expose these species to explosive sound and energy that may result in 6 TTS, 1 PTS, and 3 slight lung injuries over a five-year period.
- Predicted impacts on phocid seals would be identical to impacts predicted under the No Action Alternative.
- As with the No Action Alternative, testing activities may expose manatees to sound and energy from underwater explosives within the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is nearshore and partially within the surf zone.

These activities do not overlap bowhead whale, beluga whale, narwhal, walrus, or polar bear habitat. Therefore, it is very unlikely that these marine mammal species would be exposed to noise or energy from explosions.

Impacts on marine mammals due to explosive energy and sound increase under Alternative 1 compared to the No Action Alternative, especially due to the inclusion of ship shock trials. As described under the No Action Alternative, mortalities and lung injuries are overpredicted; hearing loss may affect an animal's ability to detect relevant sounds for a short period or permanently, depending on the level of exposure; and behavioral reactions could occur, although occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences. Generally, if long-term consequences for a few animals in populations that number in the tens of thousands do occur, they are unlikely to have measureable long-term consequences for populations. However, ranges to mortality and lung injury for ship shock trials can be up to a few kilometers from the point of detonation, thereby potentially encompassing tens of square kilometers. If a large group of marine mammals (e.g., a large pod of dolphins) were within this area during the detonation, impacts on localized stocks or populations could be substantial; however, it is important to note that there are additional protections offered by mitigation measures (discussed in Section 3.4.3.1.5.6, Implementing Mitigation to Reduce Sound Exposures), which are known to be effective and will reduce exposures to marine mammals, but are not considered in the quantitative adjustment of the tabulated impacts.

Pursuant to the MMPA, the use of explosive sources during annually recurring testing activities as described under Alternative 1:

- *may expose marine mammals up to 728 times annually to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to 116 times annually to sound or energy levels that would be considered Level A harassment; and*
- *may expose up to 10 marine mammals annually to explosive energy that may cause mortality.*

Pursuant to the MMPA, the use of explosive sources during the testing activity aircraft carrier sea trials conducted once per five-year period as described under Alternative 1 would not expose marine mammals to sound or energy levels that would be considered Level A or Level B harassment, or result in a mortality.

Pursuant to the MMPA, the use of explosive sources during the testing activity aircraft carrier ship shock trial conducted once per five-year period as described under Alternative 1:

- *may expose marine mammals up to 4,607 times to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to 6,591 times to sound or energy levels that would be considered Level A harassment; and*
- *Though the acoustic analysis predicts that up to 445 marine mammal mortalities may occur, based on conservativeness of the model, conservativeness of the impact criteria and thresholds, and past monitoring results, this event may expose up to 10 marine mammals over a five-year period to explosive energy that may cause mortality.*

Pursuant to the MMPA, the use of explosive sources during the testing activity guided missile destroyer and Littoral Combat Ship shock trials conducted three times per five-year period as described under Alternative 1:

- *may expose marine mammals up to 289 times per event to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to 396 times per event to sound or energy levels that would be considered Level A harassment; and*
- *though the acoustic analysis predicts that up to 29 marine mammal mortalities may occur, based on conservativeness of the model, conservativeness of the impact criteria and thresholds, and past monitoring results, these events may expose up to 15 marine mammals per event and no more than 15 marine mammals total over a five-year period to explosive energy that may cause mortality.*

Table 3.4-25, Table 3.4-28, and Table 3.4-29 present the Navy's marine mammal predicted exposures for testing activities under Alternative 1.

Pursuant to the ESA, the use of explosive sources during testing activities as described under Alternative 1:

- *may affect and is likely to adversely affect the ESA-listed sei whale, fin whale, humpback whale, and sperm whale;*
- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, blue whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.9.8 Alternative 2 (Preferred Alternative) – Training Activities

Proposed training activities under Alternative 2 are identical to training activities proposed under Alternative 1. Therefore, the predicted impacts for Alternative 2 are identical to those described above in Section 3.4.3.1.9.6 (Alternative 1 – Training Activities).

Pursuant to the MMPA, the use of explosive sources during training activities as described under Alternative 2:

- *may expose marine mammals up to 912 times annually to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to 262 times annually to sound or energy levels that would be considered Level A harassment;*
- *may expose marine mammals up to 7 times during each biennial civilian port defense activity to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to one time during each biennial civilian port defense activity to sound or energy levels that would be considered Level A harassment; and*
- *may expose up to 17 marine mammals annually to explosive energy that may cause mortality.*

Table 3.4-23 and Table 3.4-27 present the Navy's marine mammal predicted exposures for training activities under Alternative 2.

Pursuant to the ESA, the use of explosive sources during training activities as described under Alternative 2:

- *may affect and is likely to adversely affect the ESA-listed sperm whale, sei whale, fin whale, humpback whale, and North Atlantic right whale;*
- *may affect but is not likely to adversely affect the ESA-listed blue whale;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, polar bear, and West Indian manatee; and*
- *will have no effect on North Atlantic right and West Indian manatee critical habitats.*

3.4.3.1.9.9 Alternative 2 (Preferred Alternative) – Testing Activities

The number of annual testing activities that use explosives under Alternative 2 would increase by a factor of three over the No Action Alternative; however, the amount of explosive munitions would only increase by approximately 10 percent over the No Action Alternative. Section 3.4.3.1.9.3 (Predicted Impacts from Explosives) describes predicted impacts on marine mammals. This includes overall increases to amphibious warfare, anti-surface warfare, anti-submarine warfare, and mine warfare. A more detailed description of these testing activities and their proposed locations is in Table 2.8-2 and Table 2.8-3 and in Section 3.0.5.3.1 (Acoustic Stressors). These activities would happen in the same general locations under Alternative 2 as under the No Action Alternative.

New testing activities proposed under Alternative 2 are identical in location and number as those proposed under Alternative 1. Section 3.4.3.1.9.7 (Alternative 1 – Testing Activities) discusses these additional activities (one aircraft carrier sea trial and four ship shock trials) and the resulting predicted impacts.

The increase in proposed annually recurring testing activities under Alternative 2 over the No Action Alternative would increase overall predicted impacts on marine mammals (behavioral reactions, hearing loss, injuries, and mortalities) by 103 percent, in addition to the predicted effects due to ship shock trials. This could mean an increase in the number of individual animals exposed per year or an increase in the number of times per year some animals are exposed, although the types and severity of individual responses to explosions are unlikely to change. Predicted acoustic impacts on marine mammals from exposure to explosions from annually recurring testing activities under Alternative 2 are shown in Table 3.4-25, for aircraft carrier shock trials in Table 3.4-28, for guided missile destroyer and Littoral Combat Ship shock trials in Table 3.4-29. Notable differences in the number of predicted impacts on marine mammals from explosions between Alternative 2 and the No Action Alternative are similar to the differences between Alternative 1 and the No Action Alternative, as discussed above in Section 3.4.3.1.9.7 (Alternative 1 – Testing Activities), with three notable exceptions:

- Predicted impacts on ESA-listed species would increase slightly with one additional predicted TTS to a fin whale, one additional predicted TTS to a sei whale, and one additional predicted behavioral reaction of a sperm whale compared to the No Action Alternative for annual testing. Impacts on ESA-listed species due to ship shock trials are identical to those discussed under Alternative 1.
- Predicted impacts on harbor porpoises would increase by about 76 percent over the No Action Alternative due the increase in annual testing activities. Impacts on harbor porpoises from ship shock trials would be identical to those discussed above under Alternative 1. Predicted impacts on phocid seals under Alternative 2 would increase by 68 percent over the No Action Alternative to 15 predicted behavioral responses, 15 TTS, and 2 potential PTS. As with the No Action Alternative, testing activities may expose manatees to sound and energy from underwater explosives within the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is nearshore and partially within the surf zone.

Impacts on marine mammals due to explosive energy and sound increase under Alternative 2 compared to the No Action Alternative, especially due to the inclusion of ship shock trials, although the types and severity of individual responses to explosions are unlikely to change. As described under the No Action Alternative, mortalities and lung injuries are overpredicted, hearing loss may affect an animal’s ability to detect relevant sounds for a short period or permanently depending on the level of exposure, and behavioral reactions could occur, although occasional behavioral reactions to intermittent explosions are unlikely to cause long-term consequences. Generally, if long-term consequences for a few animals in populations that number in the tens of thousands do occur, they are unlikely to have measureable long-term consequences for populations. However, ranges to mortality and lung injury for shock trials can be up to a few kilometers from the point of detonation, thereby potentially encompassing tens of square kilometers. If a large group of marine mammals (e.g., a large pod of dolphins) were within this area during the detonation, impacts on localized populations could be substantial, making long-term consequences for the stock or overall population more likely.

It is important to note, as discussed in Section 3.4.3.1.5.6 (Implementing Mitigation to Reduce Sound Exposures), that there are additional protections offered by mitigation measures (as described in detail in Chapter 5; Standard Operating Procedures, Mitigation, and Monitoring) which will further reduce potential impacts to marine mammals, but are not considered in the quantitative adjustment of the model predicted effects. Pursuant to the MMPA, the use of explosive sources during testing activities as described under Alternative 2:

- *may expose marine mammals up to 1,061 times annually to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to 162 times annually to sound or energy levels that would be considered Level A harassment; and*
- *may expose up to 11 marine mammals annually to explosive energy that may cause mortality.*

Pursuant to the MMPA, the use of explosive sources for the testing activity aircraft carrier sea trials conducted once per five-year period as described in Alternative 2 would not expose marine mammals to levels of sound or energy that would be considered Level A or Level B harassment, or result in a mortality.

Pursuant to the MMPA, the use of explosive sources during the testing activity aircraft carrier ship shock trial conducted once per five-year period as described under Alternative 2:

- *may expose marine mammals up to 4,607 times to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to 6,591 times to sound or energy levels that would be considered Level A harassment; and*
- *though the acoustic analysis predicts that up to 445 marine mammal mortalities may occur, based on conservativeness of the model, conservativeness of the impact criteria and thresholds, and past monitoring results, this event may expose up to 10 marine mammals over a 5-year period to explosive energy that may cause mortality.*

Pursuant to the MMPA, the use of explosive sources during the testing activity guided missile destroyer and Littoral Combat Ship shock trials conducted three times per five-year period as described under Alternative 2:

- *may expose marine mammals up to 289 times per event to sound or energy levels that would be considered Level B harassment;*
- *may expose marine mammals up to 396 times per event to sound or energy levels that would be considered Level A harassment; and*
- *though the acoustic analysis predicts that up to 29 marine mammal mortalities may occur, based on conservativeness of the model, conservativeness of the impact criteria and thresholds, and past monitoring results, these events may expose up to 15 marine mammals over a five-year period to explosive energy that may cause mortality.*

Table 3.4-25, Table 3.4-28, and Table 3.4-29 present the Navy's marine mammal predicted exposures for testing activities under Alternative 2.

Pursuant to the ESA, the use of explosive sources during testing activities as described under Alternative 2:

- *may affect and is likely to adversely affect the ESA-listed fin whale, sei whale, humpback whale, and sperm whale;*
- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, blue whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.10 Impacts from Pile Driving

Construction of the elevated causeway system, a temporary pier allowing offloading of supply ships, would require pile driving and pile removal during Joint Logistics Over-the-Shore training. A separate environmental assessment has been prepared to address impacts due to all activities that occur during Joint Logistics Over-the-Shore training, with the exception of impacts due to in-water noise generated during construction of the elevated causeway. This EIS/OEIS includes analysis of the impact of underwater noise generated by pile driving during elevated causeway construction to facilitate holistic analysis of impacts due to all underwater noise generated during training and testing in the Study Area.

Marine mammals could be exposed to sounds from impact and vibratory pile driving during the construction and removal phases of the elevated causeway. Sounds produced during pile driving are described in Section 3.0.5.3.1.3 (Pile Driving). This activity would involve intermittent impact pile driving of 24-inch, uncapped, steel pipe piles over about two weeks at a rate of about eight piles per day, one pile at a time, for a total of approximately 100 piles. Each pile takes about 10 minutes to drive. When training events that use the elevated causeway system are complete, the structure would be removed. The piles would be removed using vibratory methods over seven to ten days. Crews can remove about 14 piles per day, each taking about six minutes to remove. The duration of pile driving during installation and removal of piles is as follows:

Impact pile driving (approximately 100 piles):

100 piles/8 piles per day = 12.5 days

8 piles x 10 minutes impact driving per pile = 80 minutes per day

Portion of day impact pile driving noise produced = 6 percent

Vibratory pile removal (approximately 100 piles):

100 piles/14 piles per day = 7.1 days

14 piles x 6 minutes vibratory removal per pile = 84 minutes per day

Portion of day impact pile driving noise produced = 6 percent

3.4.3.1.10.1 Model-Predicted Effects

Underwater noise effects from pile driving were modeled using a conservative estimate of geometric spreading loss of sound in shallow coastal waters. A spreading loss of 15*Log(radius) was used to estimate range (r) to the relevant pile driving criteria. A calculation of marine mammal exposures is then estimated by:

Exposure estimate = (n *(πr^2/2)) * days of pile installation/removal

Where:

n = density estimate used for each species/season
r = range to pile driving noise criteria threshold(s)
$\pi \approx 3.1415926$

The exposure estimate was calculated separately for the impact and the vibratory pile driving activities and combined to predict the total number of expected exposures. Four species of marine mammals have a density estimate occurring near the coastal pile driving locations. The West Indian manatee has no density estimate available for the Virginia and North Carolina inland coastal waters but may occur during the summer months. Therefore, the West Indian manatee was only qualitatively assessed. The resulting tables of marine mammal exposures are listed in Table 3.4-34 and Table 3.4-35.

Table 3.4-34: Predicted Effects on Marine Mammals from Pile Driving Activities Associated with the Construction and Removal of the Elevated Causeway System at Joint Expeditionary Base Fort Story or Little Creek, Virginia.
(This represents a single event at either location; effect predictions were identical due to the proximity of the proposed sites.)

Species	Impact Pile Driving		Vibratory Pile Driving		Total Predicted Exposures	
	Level A 180 dB rms	Level B 160 dB rms	Level A 180 dB rms	Level B 120 dB rms	MMPA Level A	MMPA Level B
Bottlenose Dolphin	1	302	0	294	1	596
North Atlantic Right Whale	0	0	0	0	0	0
Fin Whale	0	0	0	0	0	0
Humpback Whale	0	0	0	0	0	0

dB: decibel; MMPA: Marine Mammal Protection Act; rms: root mean square

Table 3.4-35: Predicted Effects on Marine Mammals from Pile Driving Activities Associated with the Construction and Removal of the Elevated Causeway System at Marine Corps Base Camp Lejeune, North Carolina

Species	Impact Pile Driving		Vibratory Pile Driving		Total Predicted Exposures	
	Level A 180 dB rms	Level B 160 dB rms	Level A 180 dB rms	Level B 120 dB rms	MMPA Level A	MMPA Level B
Bottlenose Dolphin	0	4	0	743	0	747
North Atlantic Right Whale	0	0	0	0	0	0
Fin Whale	0	0	0	0	0	0
Humpback Whale	0	0	0	0	0	0

dB: decibel; MMPA: Marine Mammal Protection Act; rms: root mean square

3.4.3.1.10.2 No Action Alternative

Under the No Action Alternative, pile driving associated with construction and removal of the elevated causeway system would not occur. No pile driving associated with training or testing is proposed under the No Action Alternative.

3.4.3.1.10.3 Alternative 1 – Training Activities

As described in Table 2.8-1 and Section 3.0.5.3.1.3 (Pile Driving), training activities under Alternative 1 include pile driving associated with constructing and removing the elevated causeway system. This activity would take place nearshore and within the surf zone, once per year at either Marine Corps Base Camp Lejeune, Jacksonville, North Carolina or Joint Expeditionary Base Little Creek and Fort Story, Virginia. The two areas in Virginia are within the Northeast U.S. Continental Shelf Large Marine Ecosystem, and the area in North Carolina is within the Southeast U.S. Continental Shelf Large Marine Ecosystem. The pile driving locations are adjacent to Navy pierside locations in industrialized waterways that carry a high volume of vessel traffic in addition to Navy vessels using the pier. These coastal areas tend to have high ambient noise levels due to natural and anthropogenic sources and have limited numbers of sensitive marine mammal species present.

Impulses from the impact hammer are broadband and carry most of their energy in the lower frequencies. The impulses are within the hearing range of most marine mammals and can produce a shock wave that is transmitted to the sediment and water column (Reinhall and Dahl 2011). Impact pile driving has the potential to cause some permanent hearing loss if the animal is exposed within 47 meters of the pile driving location. However, given the low abundance of marine mammals and the short duration of the activity, it is very unlikely that a marine mammal would be exposed to sound levels high enough to cause injury.

Beyond this range to effects for impact pile driving, only behavioral impacts are expected to occur out to a maximum distance of 1 km. The impulses produced are less than 1 second each and can occur at a rate of 30–50 impulses per minute. Despite the short duration of each impulse, the rate of impulses has the potential to result in some auditory masking in marine mammals and has the potential to cause some temporary physiological stress. However, given the low abundance of marine mammals, the short duration of the activity, and the likelihood that an exposed animal will avoid the immediate area, it is unlikely that a marine mammal would be exposed to noise that would result in a prolonged behavioral response, and any behavioral effect would be temporary and not significant.

Sound produced from a vibratory hammer is similar in frequency range as that of the impact hammer, except the source levels are much lower than the impact hammer. Since the vibrations oscillate at a rate of 1,700 cycles per minute, the sound source is treated as a continuous sound source in this assessment. The range to effect for the injury zone at less than 3 m is much smaller than the impact pile driving range. Given the low abundance of marine mammals and the mitigation measures, it is unlikely that a marine mammal would be exposed to injurious levels of sound from the vibratory hammer.

Though the vibratory hammer produces a much lower source level than the impact hammer, marine mammal behavioral effects can occur out to a range of 22 kilometers due to a much lower behavioral threshold (sound pressure level of 120 dB re 1µPa). Therefore, the potential to behaviorally affect marine mammals is greater, although the threshold used likely overestimates the number of biologically significant reactions, especially at ranges greater than a few kilometers. The vibratory hammer has the potential to cause auditory masking in marine mammals, but the effect would be temporary and would result in the animals most likely avoiding the immediate area if the effects were to be significant to the individuals. Any avoidance of the area is expected to be temporary and only occur while the vibratory hammer is in use.

Pile driving activities associated with training under Alternative 1 may cause nearshore species of marine mammals (e.g., bottlenose dolphins) to avoid the area near the event, although the activity potentially impacts a small area over a short duration and happens infrequently (once per year). Therefore, long-term consequences to individuals or populations are unlikely. Although ESA-listed North Atlantic right whales, humpback whales, and fin whales are present in the Study Area, it is unlikely that pile driving activities and this species would co-occur based on the expected locations of training, best available science regarding marine mammal densities (see Section 3.4.3.1.5.1, Marine Mammal Density), and the typical short duration of the activities. The quantitative analysis of pile driving impacts predicts that these species are unlikely to be affected by pile driving or removal. Proposed activities do not overlap the habitats of blue whale, sperm whale, sei whale, bowhead whale, ringed seal, or polar bear. Therefore, these species would not be impacted by pile driving noise. Pile driving activities do not occur within or near West Indian manatee or North Atlantic right whale critical habitat and therefore would not affect this resource.

Pursuant to the MMPA, the use of pile driving during training activities as described under Alternative 1:

- *may expose bottlenose dolphins to sound levels up to 747 times per year that would be considered Level B harassment and*
- *may expose one bottlenose dolphin per year to sound levels that would be considered Level A harassment.*

Table 3.4-34 and Table 3.4-35 present the Navy's marine mammal predicted exposures for training activities under Alternative 1.

Pursuant to the ESA, the use of pile driving during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, fin whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, sei whale, blue whale, sperm whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.10.4 Alternative 1 – Testing Activities

Testing activities under Alternative 1 do not include pile driving.

3.4.3.1.10.5 Alternative 2 (Preferred Alternative) – Training Activities

Proposed training activities under Alternative 2 are identical to training activities proposed under Alternative 1. Therefore, the predicted impacts for Alternative 2 are identical to those described above in Section 3.4.3.1.10.3 (Alternative 1 – Training Activities).

Pursuant to the MMPA, the use of pile driving during training activities as described under Alternative 2:

- *may expose bottlenose dolphins to sound levels up to 747 times per year that would be considered Level B harassment and*
- *may expose one bottlenose dolphin per year to sound levels that would be considered Level A harassment.*

Table 3.4-34 and Table 3.4-35 present the Navy's marine mammal predicted exposures for training activities under Alternative 2.

Pursuant to the ESA, the use of pile driving during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, fin whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, sei whale, blue whale, sperm whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.10.6 Alternative 2 (Preferred Alternative) – Testing Activities

Testing activities under Alternative 2 do not include pile driving.

3.4.3.1.11 Impacts from Swimmer Defense Airguns

Marine mammals could be exposed to noise from swimmer defense airguns during pierside swimmer defense and stationary source testing activities. Swimmer defense airgun testing involves a limited number (up to 100 per event) of impulses from a small (60 cubic inch [$in.^3$]) airgun. Section 3.0.5.3.1.4 (Swimmer Defense Airguns) provides additional details on the use and acoustic characteristics of swimmer defense airguns.

Activities using airguns were modeled using the Navy Acoustic Effects Model. Model predictions indicate that no marine mammals would be exposed to sound or acoustic energy from swimmer defense airguns that would likely elicit a physiological or behavioral response.

3.4.3.1.11.1 No Action Alternative – Training Activities

Training activities under the No Action Alternative do not include the use of the swimmer defense airguns.

3.4.3.1.11.2 No Action Alternative – Testing Activities

Testing activities under the No Action Alternative would include the use of swimmer defense airguns up to five times per year pierside at Joint Expeditionary Base Little Creek in Virginia Beach, Virginia, and up to five times per year pierside at Newport, Rhode Island, as described in Table 2.8-3. Both areas are within the inland waters of the Northeast U.S. Continental Shelf Large Marine Ecosystem. Stationary Source Testing at Naval Surface Warfare Center, Panama City Division Testing Range is not analyzed under the No Action Alternative.

Single, small airguns (60 $in.^3$) would not cause direct trauma to marine mammals. Impulses from airguns lack the strong shock wave and rapid pressure increase as would be expected from explosive sources that can cause primary blast injury or barotrauma.

Impulses from swimmer defense airguns could potentially cause temporary hearing loss for animals within a few meters of the sound source, but given the relatively low source levels and mitigation measures, this is very unlikely. The Navy Acoustic Effects Model predicted that no marine mammals would be exposed to levels capable of causing TTS or PTS.

Airguns do produce broadband sounds; however, the duration of an individual impulse is about 0.1 second. Airguns could be fired up to 100 times per event but would generally be used less based on the actual testing requirements. The pierside areas where these activities are proposed are inshore, with high levels of use and therefore high levels of ambient noise (Section 3.0.4.5, Ambient Noise). Additionally these areas have low densities of marine mammals. Therefore, auditory masking to marine mammals due to the limited testing of the swimmer defense airgun associated with integrated pierside swimmer defense is unlikely.

The Navy Acoustic Effects Model predicted that no marine mammals would be exposed to levels likely to cause significant behavioral reactions. The behavioral response of marine mammals to airguns, especially with multiple airguns firing simultaneously and repeating at regular intervals, has been well studied in conjunction with seismic surveys (e.g., oil and gas exploration). Many of these studies are reviewed above in Section 3.4.3.1.2.5 (Behavioral Reactions). However the swimmer defense airgun testing involves the use of only one small (60 $in.^3$) airgun firing a limited number of times, so reactions from marine mammals would likely be much less than what is noted in studies of marine mammal reactions during large-scale seismic studies. Furthermore, the swimmer defense airgun has limited overall use throughout the year. Impacts on marine mammals are not expected from testing of the swimmer defense airgun.

Swimmer defense airgun activities associated with testing under the No Action Alternative do not overlap the habitats of North Atlantic right whale, bowhead whale, blue whale, fin whale, humpback whale, sei whale, sperm whale, ringed seal, bearded seal, or polar bear. Therefore, these species would not be impacted by swimmer defense airgun testing noise. The West Indian manatee is rarely seen in the lower Chesapeake Bay (only in the summer) and, if present, manatees would be unlikely to enter the Joint Expeditionary Base Little Creek harbor due to the high vessel traffic in the area. The proposed activities are not within or near West Indian manatee or North Atlantic right whale critical habitat.

Pursuant to the MMPA, the use of swimmer defense airguns during testing activities as described under the No Action Alternative is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of swimmer defense airguns during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed West Indian manatee;*
- *will have no effect on the ESA-listed North Atlantic right whale, bowhead whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.11.3 Alternative 1 – Training Activities

Training activities under Alternative 1 do not include the use of swimmer defense airguns.

3.4.3.1.11.4 Alternative 1 – Testing Activities

As described in Table 2.8-3, testing activities under Alternative 1 would include the use of swimmer defense airguns at Joint Expeditionary Base Little Creek, Virginia, up to two times per year, and pierside at Newport, Rhode Island, up to five times per year. Both of these areas are within the inland waters of the Northeast U.S. Continental Shelf Large Marine Ecosystem. Stationary source testing at Naval Surface Warfare Center, Panama City Division includes a limited amount of swimmer defense airgun use that could occur up to 10 times per year. This area is in inland waters, within the Gulf of Mexico Large Marine Ecosystem.

The proposed pierside swimmer defense activities under Alternative 1 represent a decrease of three events per year compared to the No Action Alternative. Therefore, the associated impacts would differ in quantity, but the types and severity of impacts would not be discernible from those discussed above in Section 3.4.3.1.11.2 (No Action Alternative – Testing Activities).

The Navy Acoustic Effects Model predicted no effects on marine mammals due to the use of the swimmer defense airgun within Stationary Source Testing at Naval Surface Warfare Center, Panama City Division Testing Range. The types and severity of impacts would not differ from those described above in Section 3.4.3.1.11.2 (No Action Alternative – Testing Activities); however, the West Indian manatee is an occasional visitor to the inland waters of the panhandle of Florida. As with other marine mammals, manatees may avoid the area immediately around the swimmer defense airgun while it is being used, although the use of the system is very limited in this area.

Pursuant to the MMPA, the use of swimmer defense airguns during testing activities as described under Alternative 1 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of swimmer defense airguns during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed West Indian manatee;*
- *will have no effect on the ESA-listed North Atlantic right whale, bowhead whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.11.5 Alternative 2 (Preferred Alternative) – Training Activities

Training activities under Alternative 2 do not include the use of the swimmer defense airguns.

3.4.3.1.11.6 Alternative 2 (Preferred Alternative) – Testing Activities

As described in Table 2.8-3, testing activities under Alternative 2 would include the use of swimmer defense airguns at Joint Expeditionary Base Little Creek, Virginia, up to three times per year, and pierside at Newport, Rhode Island, up to six times per year. Both of these areas are within the inland waters of the Northeast U.S. Continental Shelf Large Marine Ecosystem. Stationary Source Testing at Naval Surface Warfare Center, Panama City Division Testing Range includes a limited amount of swimmer defense airgun use that could occur up to 11 times per year. This area is in inland waters, within the Gulf of Mexico Large Marine Ecosystem.

The proposed pierside swimmer defense activities under Alternative 2 represents a decrease of one event per year compared to the No Action Alternative. Therefore, the associated impacts would differ in quantity, but the types and severity of impacts would not be discernible from those discussed above in Section 3.4.3.1.11.2 (No Action Alternative – Testing Activities). Proposed stationary source testing activities under Alternative 2 represent an increase of one event per year over Alternative 1. The associated impacts would differ in quantity; however, the types and severity of impacts would not be discernible from those described above in Section 3.4.3.1.11.4 (Alternative 1 – Testing Activities).

Pursuant to the MMPA, the use of swimmer defense airguns during testing activities as described under Alternative 2 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of swimmer defense airguns during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed West Indian manatee;*
- *will have no effect on the ESA-listed North Atlantic right whale, bowhead whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.12 Impacts from Weapons Firing, Launch, and Impact Noise

Marine mammals may be exposed to weapons firing and launch noise, sound from the impact of non-explosive munitions on the water's surface, as well as noise from in-air explosions. A detailed description of these stressors is in Section 3.0.5.3.1.5, Weapons Firing, Launch, and Impact Noise. Reactions by marine mammals to these specific stressors have not been recorded; however, marine mammals would be expected to react to weapons firing, launch, and non-explosive impact noise as they would other transient sounds (Section 3.4.3.1.2.5, Behavioral Reactions).

3.4.3.1.12.1 No Action Alternative – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives) and Table 2.8-1, training activities under the No Action Alternative include activities that produce in-water noise from weapons firing, launch, non-explosive munitions impact with the water's surface, and noise from in-air explosions. Activities are spread throughout the Study Area but would be concentrated in VACAPES, Navy Cherry Point, and JAX Range Complexes, with fewer events in the GOMEX and Northeast Range Complexes. These activities could take place within any large marine ecosystem or open ocean area but would be concentrated within the Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems and Gulf Stream Open Ocean Area. 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.

A gun fired from a ship on the surface of the water propagates a blast wave away from the gun muzzle into the water (Section 3.0.5.3.1.5, Weapons Firing, Launch, and Impact 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 or populations.

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 individuals or populations.

Mines, non-explosive bombs, and intact missiles and targets could impact the water with great force and produce a large impulse and loud noise (Section 3.0.5.3.1.5, Weapons Firing, Launch, and Impact 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 and population are unlikely.

Manatees prefer inland waters and would not encounter noise from weapons firing, launch, and non-explosive munitions impact with the water's surface associated with proposed Navy training activities that typically occur more than 12 nm from shore. These activities would not take place within or near West Indian manatee critical habitat.

In-water noise from weapons firing, launch, and non-explosive munitions impact with the water's surface would not impact the assumed primary constituent elements of the North Atlantic right whale critical habitat (i.e., water temperature and depth in the southeast and copepods in the northeast).

Training activities proposed under the No Action Alternative do not overlap bowhead whale, polar bear, or ringed seal habitat. Therefore, these species would not be impacted by noise from weapons firing, launch, and non-explosive munitions impact with the water's surface associated with proposed Navy training activities. Mitigation measures implemented by the Navy (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) are designed to further reduce potential impacts.

Pursuant to the MMPA, weapons firing, launch, and non-explosive impact noise from training activities as described under the No Action Alternative is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, weapons firing, launch, and non-explosive impact noise from training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, and fin whale;*
- *will have no effect on the ESA-listed West Indian manatee, bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.12.2 No Action Alternative – Testing Activities

As described in Table 2.8-2 and Table 2.8-3, testing activities under the No Action Alternative include activities that produce in-water noise from weapons firing, launch, non-explosive munitions impact with the water's surface, and noise from in-air explosions. Activities are spread throughout the Study Area but would be concentrated in the GOMEX and Northeast Range Complexes. These activities could take place within any large marine ecosystem or open ocean area but would be concentrated within the Northeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems and Gulf Stream Open Ocean Area.

Proposed testing activities under the No Action Alternative that produce in-water noise from weapons firing, launch, non-explosive munitions impact with the water's surface, and noise from in-air explosions differ in number and location from training activities under the No Action Alternative. The associated impacts would differ in quantity and location; however, the types and severity of impacts would not be discernible from those described above in Section 3.4.3.1.13.1 (No Action Alternative – Training Activities).

Manatees prefer inland waters and would not encounter noise from weapons firing, launch, and non-explosive munitions impact with the water's surface associated with proposed Navy testing activities that typically occur offshore. These activities would not take place within or near West Indian manatee critical habitat.

Testing activities proposed under the No Action Alternative do not overlap bowhead whale, polar bear, or ringed seal habitat.

Pursuant to the MMPA, weapons firing, launch, and non-explosive impact noise from testing activities as described under the No Action Alternative is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, weapons firing, launch, and non-explosive impact noise from testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, and fin whale;*
- *will have no effect on the ESA-listed West Indian manatee, bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.12.3 Alternative 1 – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), training activities under Alternative 1 include activities that produce in-water noise from weapons firing, launch, non-explosive munitions impact with the water's surface, and noise from in-air explosions. Activities may occur throughout the Study Area but would be concentrated in VACAPES, Navy Cherry Point, and JAX Range Complexes, with fewer events in the GOMEX and Northeast Range Complexes. These activities could take place within any large marine ecosystem or open ocean area but would be concentrated within the Southeast U.S. Continental Shelf, Northeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems and Gulf Stream Open Ocean Area.

Proposed Training Activities under Alternative 1 that produce in-water noise from weapons firing, launch, non-explosive munitions impact with the water's surface, and noise from in-air explosions differ in number from training activities proposed under the No Action Alternative. The associated impacts would differ in quantity; however, the locations, types, and severity of impacts would not be discernible from those described above in Section 3.4.3.1.12.1 (No Action Alternative – Training Activities).

Pursuant to the MMPA, weapons firing, launch, and non-explosive impact noise from training activities as described under Alternative 1 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, weapons firing, launch, and non-explosive impact noise from training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, and fin whale;*
- *will have no effect on the West Indian manatee, bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.12.4 Alternative 1 – Testing Activities

As described in Tables 2.8-2 to 2.8-3, testing activities under the No Action Alternative include activities that produce in-water noise from weapons firing, launch, non-explosive munitions impact with the water's surface, and noise from in-air explosions. Activities are distributed throughout the Study Area but would be concentrated in the GOMEX and Northeast Range Complexes. These activities could take place within any large marine ecosystem or open ocean area but would be concentrated within the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems Gulf Stream Open Ocean Area.

Proposed Testing Activities under Alternative 1 that produce in-water noise from weapons firing, launch, non-explosive munitions impact with the water's surface, and noise from in-air explosions differ in number and location from training activities proposed under the No Action Alternative. The associated impacts would differ in quantity and location; however, the types and severity of impacts would not be discernible from those described above in Section 3.4.3.1.12.2 (No Action Alternative – Testing Activities).

Pursuant to the MMPA, weapons firing, launch, and non-explosive impact noise from testing activities as described under Alternative 1 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, weapons firing, launch, and non-explosive impact noise from testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, and fin whale;*
- *will have no effect on the ESA-listed West Indian manatee, bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.12.5 Alternative 2 (Preferred Alternative) – Training Activities

Proposed training activities under Alternative 2 are identical to training activities proposed under Alternative 1. Therefore, the predicted impacts for Alternative 2 are identical to those described above in Training Activities under Section 3.4.3.1.12.3 (Alternative 1 –Training Activities).

Pursuant to the MMPA, weapons firing, launch, and non-explosive impact noise from training activities as described under Alternative 2 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, weapons firing, launch, and non-explosive impact noise from training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, and fin whale;*
- *will have no effect on the ESA-listed West Indian manatee, bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.12.6 Alternative 2 (Preferred Alternative) – Testing Activities

As described in Tables 2.8-2 to 2.8-3, testing activities under the No Action Alternative include activities that produce in-water noise from weapons firing, launch, non-explosive munitions impact with the water's surface, and noise from in-air explosions. Activities are spread throughout the Study Area but would be concentrated in the GOMEX and Northeast Range Complexes. These activities could take place within any large marine ecosystem or open ocean area but would be concentrated within the Northeast U.S. Continental Shelf Gulf of Mexico Large Marine Ecosystems and Gulf Stream Open Ocean Area.

Proposed Testing Activities under Alternative 2 that produce in-water noise from weapons firing, launch, non-explosive munitions impact with the water's surface, and noise from in-air explosions differ in number and location from Training Activities proposed under the No Action Alternative. The associated impacts would differ in quantity and location; however, the types and severity of impacts would not be discernible from those described above in Section 3.4.3.1.13.1 (No Action Alternative – Training Activities).

Pursuant to the MMPA, weapons firing, launch, and non-explosive impact noise from testing activities as described under Alternative 2 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, weapons firing, launch, and non-explosive impact noise from testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, and fin whale;*
- *will have no effect on the ESA-listed West Indian manatee, bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.13 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 is in Section 3.0.5.3.1.6 (Vessel Noise). Vessel movements involve transits to and from ports to various locations within the Study Area, and many ongoing and proposed training and testing activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels).

3.4.3.1.13.1 No Action Alternative – Training Activities

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), training activities under the No Action Alternative include vessel movement in many events. Navy vessel traffic could occur anywhere within the Study Area, but would be concentrated near the Norfolk and Mayport Navy ports and within the VACAPES, Navy Cherry Point, and JAX Range Complexes. A study of Navy vessel traffic found that traffic was heaviest just offshore of Norfolk and Jacksonville, as well as along the coastal waters between the two ports (Mintz and Filadelfo 2011). Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to two weeks. In addition, a variety of smaller craft will be operated within the Study Area. Small craft types, sizes, and speeds vary. These events would be spread across the large marine ecosystems and open ocean areas designated within the Study Area. 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 all cases, the vessels/craft will be operated in a safe manner consistent with the local conditions. Section 3.4.3.1.2.5 (Behavioral Reactions) discusses scientific studies and observations of marine mammal reactions and potential auditory masking from vessel presence and noise.

Auditory masking can occur due to vessel noise, potentially masking vocalizations and other biologically important sounds (e.g., sounds of prey or predators) that marine mammals may rely on. Marine mammals have been recorded in several instances altering and modifying their vocalizations to compensate for the masking noise from vessels or other similar sounds (Holt et al. 2011; Parks et al. 2011). Potential masking can vary depending on the ambient noise level within the environment (Section 3.0.4.5, Ambient Noise and Section 3.0.4.6, Underwater Sounds), 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, especially at lower frequencies (below 100 Hz), and 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, auditory masking could occur (Section 3.0.5.7.1, Conceptual Framework for Assessing Effects from Sound-Producing Activities). 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 actually cause any substantial masking. Masking by passing ships or other sound sources transiting the Study Area would be short term, 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 auditory 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, 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 submarine are classified; however, they are quieter than most other motorized ships; by comparison a typical commercial fishing vessel produces about 158 dB re 1 µPa at 1 m (Section 3.0.5.3.1.6, Vessel Noise, describes typical noise from commercial and recreational vessels). Therefore, these surface combatants and submarines are likely to be detectable by marine mammals over open-ocean ambient noise levels (Section 3.0.4.5, Ambient Noise) at distances of up to a few kilometers, which could cause some auditory masking to marine mammals for a few minutes as the vessel passes by. Other Navy ships and small craft 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 for some large commercial vessels and outboard engines. Therefore, in the open ocean, noise from noncombatant Navy vessels may be detectable over ambient levels for tens of kilometers, and some auditory 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 auditory 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. 1995; Watkins 1981). Some species respond negatively by retreating or responding to the vessel antagonistically, while other animals seem to ignore vessel noises altogether (Watkins 1986). Marine mammals are frequently exposed to vessels due to research, ecotourism, commercial and private vessel traffic, and government activities. 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 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. Vessel noise would not impact the assumed primary constituent elements of the North Atlantic right whale critical habitat (i.e., water temperature and depth in the southeast and copepods in the northeast).

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. Such reactions are likely to be minor and short term, leading to no long-term consequences. Mitigation measures implemented to detect and avoid marine mammals (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) would further reduce the potential for significant behavioral reactions from marine mammals due to exposure from vessel noise or presence.

Most Navy activities occur more than 3 nm offshore, where manatees are uncommon; however, at pierside locations and within inland waters along the southeastern United States and in the Gulf of Mexico, manatees could co-occur with Navy vessels. In studies, manatees have reacted to vessels by moving away from the approaching vessel, increasing their swimming speed, and moving toward deeper water. Manatees within the Port Canaveral and Mayport portions of the designated West Indian manatee critical habitat areas may be exposed to vessel noise. The primary constituent elements of the habitat required by the West Indian manatee for feeding and breeding have been reported as the presences of seagrasses and warm water refuges. These elements would not be impacted by vessel noise.

Several studies have shown that marine mammals may abandon inshore and nearshore habitats with high vessel traffic, especially in areas with regular marine mammal watching (Section 3.4.3.1.2.5, Behavioral Reactions). Navy ports such as Mayport and Norfolk 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 long-term abandonment of habitat by a marine mammal.

Vessel traffic related to the proposed activity would pass near marine mammals only on an incidental basis. Navy mitigation measures include several provisions to avoid approaching marine mammals, which would further reduce any potential impacts. Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) describes mitigation measures in detail.

Pursuant to the MMPA, vessel noise from training activities as described under the No Action Alternative is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, vessel noise from training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, bowhead whale, ringed seal, West Indian manatee, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.13.2 No Action Alternative – Testing Activities

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), testing activities under the No Action Alternative include vessel movement in many events. Navy vessel traffic associated with testing could take place anywhere within the Study Area, primarily concentrated within the VACAPES, Navy Cherry Point, and JAX Range Complexes; the Northeast Range Complexes and adjacent inland waters; and in the Gulf of Mexico, especially in areas near Naval Surface Warfare Center, Panama City Division Testing Range. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to two weeks. 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/craft will be operated in a safe manner consistent with the local conditions. These events would be distributed across the large marine ecosystems and open ocean areas designated within the Study Area.

Proposed testing activities under the No Action Alternative that involve vessel movement differ in number and location from training activities under the No Action Alternative; however the types and severity of impacts would not be discernible from those described above in Section 3.4.3.1.13.1 (No Action Alternative – Training Activities).

Pursuant to the MMPA, vessel noise from testing activities as described under the No Action Alternative is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, vessel noise from testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, bowhead whale, ringed seal, West Indian manatee, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.13.3 Alternative 1 – Training Activities

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), training activities under Alternative 1 include an increase in vessel movement over the No Action Alternative; however, the locations and predicted impacts would not differ. Proposed Training Activities under Alternative 1 that involve vessel movement differ in number from Training Activities proposed under the No Action Alternative, but the locations, types, and severity of impacts would not be discernible from those described above in Section 3.4.3.1.14.1 (No Action Alternative – Training Activities).

Pursuant to the MMPA, vessel noise from training activities as described under Alternative 1 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, vessel noise from training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, bowhead whale, ringed seal, West Indian manatee, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.13.4 Alternative 1 – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), testing activities proposed under Alternative 1 would increase Navy vessel traffic from the No Action Alternative, leading to an increase in vessel-related noise in some portions of the Study Area. Additional ship trials will be conducted in the Northeast, VACAPES, JAX, and GOMEX Range Complexes, and activities that include the use of vessels would increase at the South Florida Ocean Measurement Facility Testing Range. New vessels proposed for testing under Alternative 1, such as the Littoral Combat Ship, the Joint High Speed

Vessel, and the Expeditionary Fighting Vehicle, are all fast moving, designed to operate in nearshore waters, and may increase overall noise levels in these environments. Under Alternative 1, predicted behavioral reactions and auditory masking could increase over the No Action Alternative in nearshore habitats within the Study Area due to testing activities. However, the types and severity of reactions would not differ substantially, and significant behavioral reactions by marine mammals due to passing vessel noise are not expected. Long-term consequences to individuals or populations due to the proposed activities are unlikely.

Proposed testing activities under Alternative 1 that produce underwater noise from vessel movement differ in number and location from Training Activities proposed under the No Action Alternative; however, the types and severity of impacts would not be discernible from those described above in Section 3.4.3.1.13.1 (No Action Alternative – Training Activities).

Pursuant to the MMPA, vessel noise from testing activities as described under Alternative 1 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, vessel noise from testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, bowhead whale, ringed seal, West Indian manatee, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.13.5 Alternative 2 (Preferred Alternative) – Training Activities

Proposed training activities under Alternative 2 are identical to training activities proposed under Alternative 1. Therefore, the predicted impacts for Alternative 2 are identical to those described above in Training Activities under Section 3.4.3.1.14.3 (Alternative 1 – Training Activities).

Pursuant to the MMPA, vessel noise from training activities as described under Alternative 2 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, vessel noise from training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, bowhead whale,ringed seal, West Indian manatee, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.13.6 Alternative 2 (Preferred Alternative) – Testing Activities

As described in Chapter 2, testing activities proposed under Alternative 2 would increase Navy vessel traffic from the No Action Alternative, leading to an increase in vessel-related noise in some portions of the Study Area, as described under Section 3.4.3.1.13.4 (Alternative 1 – Testing Activities). Proposed testing activities under Alternative 2 that produce underwater noise from vessel movement differ in number and location from training activities proposed under the No Action Alternative; however, the types and severity of impacts would not be discernible from those described above in Section 3.4.3.1.13.2 (No Action Alternative – Testing Activities).

Pursuant to the MMPA, vessel noise from testing activities as described under Alternative 2 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, vessel noise from testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, bowhead whale, ringed seal, West Indian manatee, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.14 Impacts from Aircraft Noise

Marine mammals may be exposed to aircraft-generated noise wherever aircraft overflights occur in the Study Area. Fixed- and rotary-wing aircraft are used for a variety of training and testing activities throughout the Study Area. 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. A severe but 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 3.0.5.3.1.7 (Aircraft Overflight Noise).

3.4.3.1.14.1 No Action Alternative – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), training activities under the No Action Alternative 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. These events would be spread across the large marine ecosystems and open ocean areas designated within the Study Area.

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 greater detail in Section 3.0.4 (Acoustic and Explosives Primer). Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. The maximum sound levels in water from an aircraft overflight are approximately 150 dB re 1µPa for an F/A-18 aircraft at 300 m altitude; approximately 125 dB re 1µPa for an H-60 helicopter hovering at 50 ft.; and under ideal conditions, sonic booms from aircraft at 1 km could reach up to 178 dB re 1µPa at the water's surface. Section 3.0.5.3.1.7 (Aircraft Overflight Noise) provides additional information on aircraft noise characteristics.

Section 3.4.3.1.2.5 (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 in the shadow of the aircraft) for extended periods. Navy aircraft would not follow or pursue 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.

In most cases, exposure of a marine mammal to fixed-wing or rotary-wing 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. Takeoff 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. Short-term reactions to aircraft are not likely to disrupt major behavior patterns such as migrating, breeding, feeding, and sheltering, or result in serious injury to any marine mammals. No long-term consequences for individuals or populations would be expected.

The sound from aircraft overflights would not impact the assumed primary constituent elements of the North Atlantic right whale critical habitat (i.e., water temperature and depth in the southeast and copepods in the northeast). Manatees within the Port Canaveral and Mayport portions of the designated West Indian manatee critical habitat areas may be exposed to aircraft overflight noise. The primary constituent element of the habitat required by the West Indian manatee for feeding and breeding have been reported as the presence of seagrasses and warm water refuges. These elements would not be impacted by aircraft overflight noise.

Under the No Action Alternative, Navy training activities within the Study Area do not spatially overlap with seal haul-out sites or bowhead whale or polar bear habitat. Therefore, polar bears, bowhead whales, and phocid seals on land would not be impacted by overflight noise. Other mysticetes, odontocetes, phocid seals in the water, and manatees could be exposed to aircraft overflight noise proposed under the No Action Alternative.

Pursuant to the MMPA, aircraft overflight noise from training activities as described under the No Action Alternative is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, aircraft overflight noise from training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, West Indian manatee, bowhead whale, and polar bear;*
- *will have no effect on the ESA-listed ringed seal; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.14.2 No Action Alternative – Testing Activities

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), testing activities under the No Action Alternative 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. These events would be spread across the large marine ecosystems and open ocean areas designated within the Study Area. Proposed testing activities under the No Action Alternative that involve aircraft overflights differ in number and location from training activities under the No Action Alternative; however, the types and severity of impacts would not be discernible from those described above in Section 3.4.3.1.14.1 (No Action Alternative – Training Activities).

Pursuant to the MMPA, aircraft overflight noise from testing activities as described under the No Action Alternative is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, aircraft overflight noise from testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, West Indian manatee, bowhead whale, and polar bear;*
- *will have no effect on the ESA-listed ringed seal; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.14.3 Alternative 1 – Training Activities

As shown in Table 2.8-1, training activities under Alternative 1 include an increase in the number of activities that involve aircraft compared to the No Action Alternative; however, the training locations, types of aircraft, and types of activities would not differ. The number of individual predicted impacts associated with Alternative 1 aircraft overflight noise may increase, but the locations, types, and severity of impacts would not be discernible from those described above in Section 3.4.3.1.14.1 (No Action Alternative – Training Activities).

Pursuant to the MMPA, aircraft overflight noise from training activities as described under Alternative 1 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, aircraft overflight noise from training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, West Indian manatee, bowhead whale, and polar bear;*
- *will have no effect on the ESA-listed ringed seal; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.14.4 Alternative 1 – Testing Activities

As shown in Table 2.8-2, testing activities under Alternative 1 include an increase in the number of events that involve aircraft compared to the No Action Alternative; however, the testing locations, types of aircraft, and types of activities would not differ. The number of individual predicted impacts associated with Alternative 1 aircraft overflight noise may increase; however, the locations, types, and severity of impacts would not be discernible from those described above in Section 3.4.3.1.14.2 (No Action Alternative – Testing Activities).

Pursuant to the MMPA, aircraft overflight noise from testing activities as described under Alternative 1 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, aircraft overflight noise from testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, West Indian manatee, bowhead whale, and polar bear;*
- *will have no effect on the ESA-listed ringed seal; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.14.5 Alternative 2 (Preferred Alternative) – Training Activities

Proposed training activities under Alternative 2 are identical to training activities proposed under Alternative 1. Therefore, the predicted impacts for Alternative 2 are identical to those described above in Training Activities under Section 3.4.3.1.14.3 (Alternative 1 – Training Activities).

Pursuant to the MMPA, aircraft overflight noise from training activities as described under Alternative 2 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, aircraft overflight noise from training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, West Indian manatee, bowhead whale, and polar bear;*
- *will have no effect on the ESA-listed ringed seal; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.1.14.6 Alternative 2 (Preferred Alternative) – Testing Activities

As shown in Table 2.8-2 and Table 2.8-3, testing activities under Alternative 2 include an increase in the number of events that involve aircraft compared to the No Action Alternative; however, the testing locations, types of aircraft, and types of activities would not differ. The number of individual predicted impacts associated with Alternative 2 aircraft overflight noise may increase, but the locations, types, and severity of impacts would not be discernible from those described in Section 3.4.3.1.14.4 (Alternative 1 – Testing Activities).

Pursuant to the MMPA, aircraft overflight noise from testing activities as described under Alternative 2 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, aircraft overflight noise from testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, sei whale, blue whale, sperm whale, humpback whale, fin whale, West Indian manatee, bowhead whale, and polar bear;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.2 Energy Stressors

This section analyzes the potential impacts of the various types of energy stressors that can occur during training and testing activities within the Study Area. This section includes analysis of the potential impacts of: (1) electromagnetic devices and (2) high energy lasers.

3.4.3.2.1 Impacts from Electromagnetic Devices

Several different types of electromagnetic devices are used during training and testing activities, primarily for magnetic influence mine sweeping. Section 3.0.5.3.2.1 (Electromagnetic Devices) discusses the types of activities that use electromagnetic devices, where they are used, and how many events will occur under each alternative. 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 magnetic fields and electromagnetic fields on cetaceans is inconclusive. Dolman et al. (2003) provides a literature review of the influences of marine wind farms on cetaceans. The literature focuses on harbor porpoises and dolphin species because of their nearshore habitats. Teilmann et al. (2002) evaluated the frequency of harbor porpoise presence at wind farm locations around Sweden (the electrical current conducted by undersea power cables creates an electromagnetic field around those cables). Although electromagnetic field influences were not specifically addressed, the presence of cetacean species implies that at least those species are not repelled by the presence of electromagnetic fields around undersea cables associated with offshore wind farms.

Based on the available literature, no evidence of electrosensitivity in marine mammals was found except recently in the Guiana dolphin (Czech-Damal et al. 2011). Based on the available literature, no evidence suggests any magnetic sensitivity for polar bears, sea otters, sea lions, fur seals, walrus, earless seals, and Sirenia (Normandeau et al. 2011). However, as described in the discussion below, some literature suggests that some cetaceans (whales, dolphins, and porpoises) may be sensitive to changes in magnetic fields.

Comparing sighting record locations (Walker et al. 1992) and live stranding record locations (Kirschvink 1990; Kirschvink et al. 1986; Klinowska 1985) with a map of the Earth's magnetic field suggests that cetaceans may be able to sense the earth's magnetic field. Results from one study showed that 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 were found to strand in areas where the earth's magnetic field was locally weaker than surrounding areas (negative magnetic anomaly) (Kirschvink 1990). Results also indicated that certain species may be able to detect total intensity changes of only 0.05 microtesla (Kirschvink et al. 1986). This gives insight into what changes in intensity levels some species are capable of detecting but does not provide experimental evidence of levels to which animals may physiologically or behaviorally respond.

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). 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. The only experimental study comes from Kuzhetsov (1999), who exposed bottlenose dolphins to permanent magnetic fields and showed reactions (both behavioral and physiological) to magnetic field intensities of 32, 108, and 168 microteslas during 79 percent, 63 percent, and 53 percent of the trials, respectively (as summarized in Normandeau et al. 2011). Behavioral reactions included sharp exhalations, acoustic activity, and movement, and physiological reactions such as a change in heart rate.

Potential impacts on marine mammals associated with electromagnetic fields depend on the animal's proximity to the source and the strength of the magnetic field. As discussed in 3.0.5.3.2.1 (Electromagnetic Devices), electromagnetic fields associated with naval training and testing activities are relatively weak (only 10 percent of the earth's magnetic field at 79 ft.), temporary, and localized. Once the source is turned off, the electromagnetic field is gone. A marine mammal would have to be within the electromagnetic field (approximately 656 ft. [200 m] from the source) during the activity to detect it.

3.4.3.2.1.1 No Action Alternative

Training Activities

As discussed in Section 3.0.5.3.2.1 (Electromagnetic Devices), under the No Action Alternative, training activities involving electromagnetic devices occur in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area, specifically within the VACAPES, Navy Cherry Point, and JAX Range Complexes. Activities involving electromagnetic devices are concentrated within the VACAPES Range Complex. Marine mammal species that do not occur within these specified areas, including the bowhead whale, narwhal, beluga whale, white-beaked dolphin, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear would not be exposed to the electromagnetic fields from Navy training. Species that do occur within the range complexes listed above would have the potential to be exposed to the electromagnetic fields.

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 movement or migration (Walker et al. 1992). If an animal was exposed to the magnetic field during a training event, it is possible that the animal would alter its originally intended course or temporarily leave the area. However, impacts would be temporary and minor, and natural behavioral patterns would not be significantly altered or abandoned based on the (1) relatively low intensity of the magnetic fields generated (discussed above), (2) very localized potential impact area, and (3) temporary duration of the activities (hours).

Training activities involving electromagnetic devices may occur within the southeast North Atlantic right whale critical habitat year round. The primary constituent elements of the habitat required by North Atlantic right whales in the Southeast have been suggested as the specific water temperature and depth ranges (Garrison 2007). However, these primary constituent elements will not be impacted by electromagnetic devices. Training activities involving electromagnetic devices will not occur within West Indian manatee critical habitat.

Pursuant to the MMPA, the use of electromagnetic devices during training activities as described under the No Action Alternative is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

Testing Activities

As discussed in Section 3.0.5.3.2.1 (Electromagnetic Devices), under the No Action Alternative, testing activities involving electromagnetic devices occur in the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, specifically within the VACAPES Range Complex Naval Surface Warfare Center, Panama City Division Testing Range. Activities involving electromagnetic device use are concentrated within the Naval Surface Warfare Center, Panama City Division Testing Range. Marine mammal species that do not occur within these specified areas, including the bowhead whale, narwhal, beluga whale, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear, would not be exposed to the electromagnetic fields from Navy testing activities. Species that do occur within the areas listed above would have the potential to be exposed to the electromagnetic fields.

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 movement or migration (Walker et al. 1992). If an animal was exposed to the magnetic field during a testing event, it is possible that the animal would alter its originally intended course or temporarily leave the area. However, impacts would be temporary and minor, and natural behavioral patterns would not be significantly altered or abandoned based on the (1) relatively low intensity of the magnetic fields generated (0.2 microtesla at 200 m from the source), (2) very localized potential impact area, and (3) temporary duration of the activities (hours).

Testing activities involving electromagnetic devices will not occur within North Atlantic right whale or West Indian manatee critical habitat.

Pursuant to the MMPA, the use of electromagnetic devices during testing activities as described under the No Action Alternative is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.2.1.2 Alternative 1

Training Activities

As discussed in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, electromagnetic device use would increase in the Study Area compared to the No Action Alternative. Training activities involving electromagnetic devices would continue to occur in the Northeast U.S. Continental Shelf and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as Gulf Stream Open Ocean Area, specifically within the VACAPES, Navy Cherry Point, and JAX Range Complexes. In addition, activities would be introduced within the Gulf of Mexico Large Marine Ecosystem, specifically within the GOMEX Range Complex, as well as the following coastal locations: Sandy Hook Bay, Earle, New Jersey; Lower Chesapeake Bay, Hampton Roads, Virginia; Beaufort Inlet Channel, Morehead City, North Carolina; Cape Fear River, Wilmington, North Carolina; St. Andrew Bay, Panama City, Florida; Sabine Lake, Beaumont, Texas; and Corpus Christi Bay, Corpus Christi, Texas. Activities involving electromagnetic device use remains concentrated within the VACAPES Range Complex.

The minor increase in events in previously identified locations and introduction of events in the additional locations as described above would not measurably increase the probability of marine mammals being exposed to electromagnetic energy compared to the No Action Alternative. The species with potential to co-occur with these events remain the same, and potential impacts would be temporary and minor, as discussed above for the No Action Alternative.

Training activities involving electromagnetic devices may occur within the southeast North Atlantic right whale critical habitat area year-round. The primary constituent elements of the habitat required by North Atlantic right whales in the southeast have been suggested as the specific water temperature and depth ranges (Garrison 2007). However, these primary constituent elements will not be impacted by electromagnetic devices. Training activities involving electromagnetic devices will not occur within West Indian manatee critical habitat.

Pursuant to the MMPA, use of electromagnetic devices during training activities as described under Alternative 1 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

Testing Activities

As discussed in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, electromagnetic device use would increase in the Study Area compared to the No Action Alternative. Testing activities involving electromagnetic devices would continue to occur in the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, specifically within the VACAPES Range Complex and the Naval Surface Warfare Center, Panama City Division Testing Range. In addition, activities would be introduced anywhere within the Gulf of Mexico, as well as the Southeast U.S. Continental Shelf Large Marine Ecosystem, specifically within the South Florida Ocean Measurement Facility Testing Range. Activities involving electromagnetic device use remain concentrated within the Naval Surface Warfare Center, Panama City Division Testing Range. As discussed in 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, the increase in events includes the introduction of kinetic energy weapon testing in the VACAPES Range Complex. The kinetic energy weapon is a new weapon system for which there are neither data nor information available to analyze potential impacts on marine mammals. This is a unique weapons system that charges for approximately two minutes and discharges in less than one second; therefore, any exposure to electromagnetic energy would be temporary and is not expected to result in impacts on organisms (U.S. Department of the Navy 2009a).

The increase in events in previously identified locations and the introduction of events in the additional locations described above would not measurably increase the probability of marine mammals being exposed to electromagnetic energy compared to the No Action Alternative. The species with potential to co-occur with these events remain the same, and potential impacts would be temporary and minor, as discussed above for the No Action Alternative.

Testing activities involving electromagnetic devices will not occur within North Atlantic right whale or West Indian manatee critical habitat.

Pursuant to the MMPA, the use of electromagnetic devices used during testing activities as described under Alternative 1 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.2.1.3 Alternative 2 (Preferred Alternative)

Training Activities

Training activities under Alternative 2 are identical to those described in 3.4.3.2.1.2 (Alternative 1 – Training Activities).

Pursuant to the MMPA, use of electromagnetic devices during training activities as described under Alternative 2 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

Testing Activities

As discussed in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 2, electromagnetic device use would increase in the Study Area compared to the No Action Alternative. Testing activities involving electromagnetic devices would continue to occur in the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, specifically within the VACAPES Range Complex and the Naval Surface Warfare Center, Panama City Division Testing Range. In addition, activities would be introduced anywhere within the Gulf of Mexico, as well as the Southeast U.S. Continental Shelf Large Marine Ecosystem, specifically within the South Florida Ocean Measurement Facility Testing Range. Activities involving electromagnetic device use remain concentrated within the Naval Surface Warfare Center, Panama City Division Testing Range.

As discussed in 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 2, the increase in events includes the introduction of kinetic energy weapon testing in the VACAPES Range Complex. The kinetic energy weapon is a new weapon system for which there are neither data nor information available to analyze potential impacts on marine mammals. This is a unique weapons system that charges for approximately two minutes and discharges in less than one second; therefore, any exposure to electromagnetic energy would be temporary and is not expected to result in impacts on organisms (U.S. U.S. Department of the Navy 2009a).

The increase in events in previously identified locations and introduction of events in the additional locations described above would not measurably increase the probability of marine mammals being exposed to electromagnetic energy compared to the No Action Alternative. The species with potential to co-occur with these events remain the same, and potential impacts would be temporary and minor, as discussed above for the No Action Alternative.

Testing activities involving electromagnetic devices will not occur within North Atlantic right whale or West Indian manatee critical habitat.

Pursuant to the MMPA, the use of electromagnetic devices during testing activities as described under Alternative 2 is not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.2.2 Impacts from High Energy Lasers

This section analyzes the potential impacts of high energy lasers on marine mammals. As discussed in Section 3.0.5.3.2.2 (Lasers), high energy laser weapons are designed to disable surface targets, rendering them immobile. The primary concern is the potential for a marine mammal to be struck with 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 impact from low energy lasers was determined to be extremely low (Section 3.0.5.3.2.2, Lasers) and therefore will not be analyzed in this section.

The potential for marine mammals to be directly struck by a high energy laser beam was evaluated using statistical probability modeling (Appendix G, Statistical Probability Analysis for Estimating Direct Strike Impact and Number of Potential Exposures) to estimate the probability of striking a marine mammal for a worst-case scenario. Model input values include high energy laser use data (frequency and footprint), size of the testing area, marine mammal density data, and animal footprint. To estimate the potential to strike a marine mammal in a worst-case scenario, the impact area of all laser events was totaled over one year in the testing area for each of the alternatives. Finally, the marine mammal species with the highest average seasonal density within the testing area was used.

Within the statistical probability model, the estimated potential for a marine mammal strike is influenced by the following assumptions:

- The model is two-dimensional and assumes that all animals would be at or near the surface 100 percent of the time, when in fact, marine mammals spend up to 90 percent of their time under the water (Costa 1993).
- The model assumes the animal is stationary and does not account for any movement of the marine mammal or any potential avoidance of the testing activity.

3.4.3.2.2.1 No Action Alternative

Under the No Action Alternative, no high energy laser weapons use is planned during training or testing activities.

3.4.3.2.2.2 Alternatives 1 and 2 (Preferred Alternative)

Training Activities

Under Alternatives 1 and 2, no high energy laser weapons use is planned during training activities.

Testing Activities

As discussed in Section 3.0.5.3.2.2 (Lasers), under Alternatives 1 and 2, high energy laser weapons tests are introduced in the Northeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area, specifically within the VACAPES Range Complex. Marine mammal species that do not occur within the VACAPES Range Complex, including the bowhead whale, narwhal, beluga whale, white-beaked dolphin, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear, would not be exposed to high energy lasers. Species that do occur within this area would have the potential to be exposed.

Based on the statistical probability model, results indicate that even for the species with the highest average seasonal density in the activity location (Atlantic spotted dolphin), the number of potential strikes annually is 0.0. Considering the assumptions in the model outlined above, there is a high level of certainty in the conclusion that a marine mammal would not be struck by a high energy laser.

Testing activities involving high energy lasers will not occur within North Atlantic right whale or West Indian manatee critical habitat.

Pursuant to the MMPA, the use of high energy lasers during testing activities as described under Alternatives 1 and 2 are not expected to result in Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of high energy lasers during testing activities as described under Alternatives 1 and 2:

- *will have no effect on the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, bowhead whale, West Indian manatee, and polar bear;*
- *will have no effect on the ESA-listed ringed seal; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.3 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; and (3) seafloor devices.

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 before reacting or being struck. Refer to sections 3.4.3.1.14 (Impacts from Vessel Noise) and 3.4.3.1.15 (Impacts from Aircraft Noise) for the analysis of the potential for disturbance from acoustic stimuli.

If a marine mammal responds to physical disturbance, the individual must stop whatever it was doing and divert its physiological and cognitive attention in response to the stressor (Helfman et al. 2009). The energetic costs of reacting to a stressor depend on the specific situation, but one can assume that the caloric requirements of a response may reduce the amount of energy available to the mammal for other functions, such as reproduction, growth, and homeostasis (Wedemeyer et al. 1990). 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.

3.4.3.3.1 Impacts from Vessels

Interactions between surface vessels and marine mammals have demonstrated that surface vessels can represent a source of acute and chronic disturbance for marine mammals (Au and Green 2000; Bejder et al. 2006a; Hewitt 1985; Lusseau et al. 2009; Magalhães et al. 2002; Nowacek et al. 2007; Nowacek et al. 2004b; Richter et al. 2006; Richter et al. 2003; Watkins 1986; Wursig and Richardson 2009; Würsig and Richardson 2008). 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 are addressed in Section 3.4.3.1.14 (Impacts from Vessel Noise).

These studies establish that marine mammals engage in avoidance behavior when surface vessels move toward them. It is not clear whether these responses are caused by the physical presence of a surface vessel, the underwater noise generated by the vessel, or an interaction between the two, although the noise generated by the vessels is probably an important contributing factor to the responses of cetaceans to the vessels. In one study, North Atlantic right whales were documented to show little overall reaction to the playback of sounds of approaching vessels, but they did respond to a novel sound by swimming strongly to the surface, which may increase their risk of collision (Nowacek et al. 2004a). 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 momentary behavioral response.

Vessel speed, size, and mass are all important factors in determining potential impacts of a vessel strike to marine mammals. For large vessels, speed and angle of approach can influence the severity of a strike. Silber et al. (2010) found, based on modeling, that whales at the surface experienced impacts that increased in magnitude with the ship's increasing speed. Results of the study also indicated that potential impacts were not dependent on the whale's orientation to the path of the ship, but that vessel speed may be an important factor. At ship speeds of 15 knots or higher, there was a marked increase in intensity of centerline impacts on whales. Results also indicated that when the whale was below the surface (about one to two times the vessel draft), there was a pronounced propeller suction effect. This suction effect may draw the whale into the hull of the ship, increasing the probability of propeller strikes (Silber et al. 2010).

Reviews of the literature on ship strikes mainly involve collisions between commercial vessels and whales (Jensen and Silber 2004; Laist et al. 2001). Navy vessels operate differently from commercial vessels in ways important to the prevention of whale collisions. As described in Section 5.1 (Standard Operating Procedures), surface ships operated by or for the Navy have personnel assigned to stand watch at all times, day and night, when a ship or surfaced submarine is moving through the water (underway). A primary duty of personnel standing watch on surface ships is to detect and report all objects and disturbances sighted in the water that may indicate a threat to the vessel and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per vessel safety requirements, personnel standing watch also report any marine mammals sighted in the path of the vessel as a standard collision avoidance procedure. All vessels use extreme caution and proceed at a safe speed so they can take proper and effective action to avoid a collision with any sighted object or disturbance, and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

The majority of the training and testing activities involve some level of vessel activity. Section 3.0.5.3.3.1 (Vessels) provides specific information on the activity types and locations that involve the use of vessels, and the speed and size characteristics of the vessels.

To determine the potential for Navy vessel strikes, the Navy assessed the probability of Navy vessels hitting individuals of different species of whales that occur in the AFTT Study Area incidental to training and testing activities. A strike probability analysis was completed based on actual data collected from historical use of Navy vessels. These data account for real world variables and any model would be expected to be less accurate than the use of actual data. Trends in the amount and location of vessel traffic and mitigation measures were also considered as important factors in the risk of strike. It is Navy policy (Chief of Naval Operations Instruction [OPNAVINST] 3100.6) to report all marine mammal strikes by Navy vessels. By an informal agreement, the information is collected by Office of the Chief of Naval Operations Environmental Readiness and provided to NMFS on an annual basis. Only Navy and the U.S. Coast Guard report in this manner, so all statistics potentially comparing Navy and Coast Guard whale strikes to other vessel types and operators are skewed against this history of voluntary reporting (Jensen and Silber 2004).

Navy and NMFS reports for the Study Area indicate that between January 1995 and May 2013, Navy vessels were involved in 20 large whale strikes (Figure 3.4-15). Eight of the strikes resulted in a confirmed death; but in 12 of the 20 strikes, the fate of the animal was undetermined. It is possible that some of the 12 reported strikes resulted only in recoverable injury or were not marine mammals at all but another large marine species (e.g., whale shark). However, it is prudent to consider that all the strikes could have resulted in the death of a marine mammal. The maximum number of strikes in any given year was three strikes, which occurred in 2001 and 2004. The highest average number of strikes over any five-year period was two strikes per year in 2001 to 2005. The average number of strikes for the entire 18.4-year period is 1.086 strikes per year. Since the implementation of the U.S. Navy's Marine Species Awareness Training in 2007, strikes in the Study Area have decreased to an average of 0.6 strikes per year. Over the last 5 years in the AFTT Study Area, the Navy was involved in only three strikes, with no confirmed marine mammal deaths as the result of a vessel strike.

It should be noted that the relatively high proportion of Navy strike reports in the scientific literature and NMFS databases compared to strikes from commercial or recreational strikes is most likely 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 an actual higher frequency of collisions relative to other ship types. Most vessel strikes of marine mammals reported involve commercial vessels and occur over or near the continental shelf (Laist et al. 2001). Given the relative vessel density, the Navy is most likely a minor contributor to the problem of vessel strikes to marine mammals.

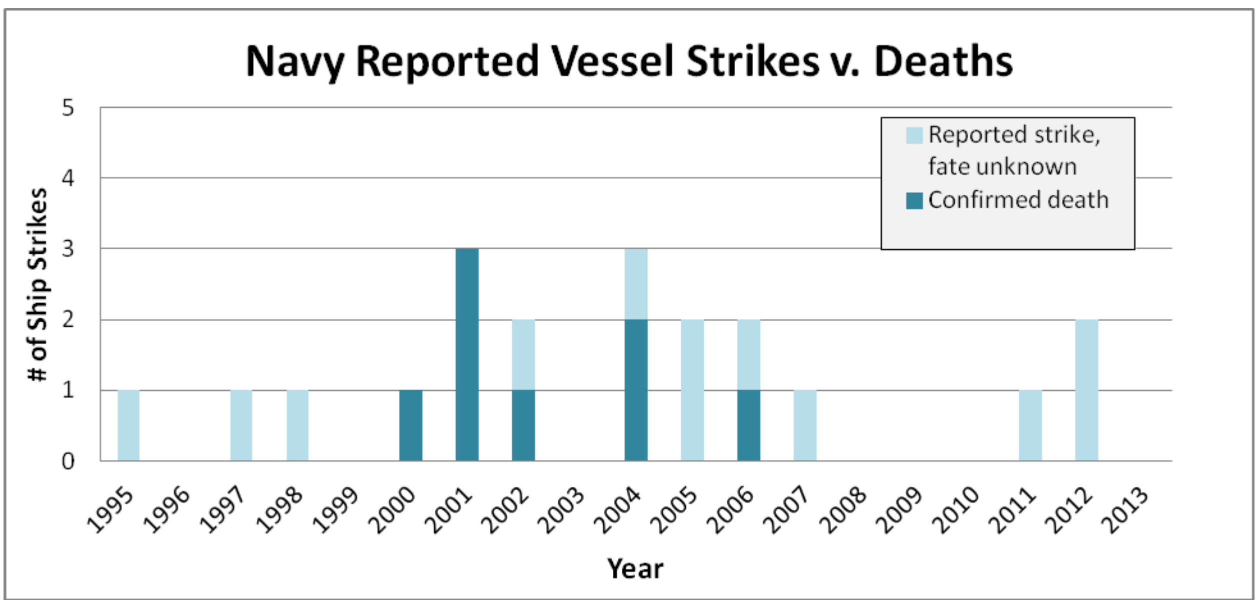


Figure 3.4-15: Navy Vessel Strikes by Type and Year (Jan 1995– May 2013)
#: number

The ability of a ship to detect a marine mammal and avoid a collision depends on a variety of factors, including environmental conditions, ship design, vessel size, number of watch personnel, and the behavior of the animal. The majority of ships participating in AFTT training and testing activities have a number of advantages for avoiding ship strikes compared to most commercial or private vessels. These advantages include:

- Many Navy ships have their bridges positioned closer to the bow, offering good visibility ahead of the ship;
- There are often aircraft associated with the training or testing activity, which can detect marine mammals in the vicinity or ahead of a vessel's present course.
- Navy ships are generally much more maneuverable than commercial merchant vessels if marine mammals are spotted and 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 addition, a standard operating procedure also added as a mitigation measure in previous MMPA permits is for Navy vessels to maneuver at least 500 yd. (457.2 m) away from any observed whale in the vessel's path and avoid approaching whales head-on, so long as safety of navigation is not imperiled.
- In many cases, Navy ships will likely move randomly or with a specific pattern within a sub-area of the AFTT Study Area for a period of time from one day to two weeks as compared to straight line point-to-point commercial shipping.
- Navy overall crew size is much larger than merchant ships allowing for more potential observers on the bridge.
- At all times when vessels are underway, trained Lookouts and bridge navigation teams are used to detect objects on the surface of the water ahead of the ship, including marine mammals. Additional Lookouts, beyond already stationed bridge watch and navigation teams, are stationed during some training events.
- Navy Lookouts receive extensive training, including Marine Species Awareness Training designed to provide marine species detection cues and information necessary to detect marine mammals.

For submarines, when on the surface there are Lookouts serving the same function as they do on surface ships and are thus able to detect and avoid marine mammals at the surface. 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. The Navy's mitigation measures are detailed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring).

Even with implementation of mitigation measures, vessel impacts from the Proposed Action represent a risk to large whales and manatees in the Study Area. The most vulnerable marine mammals are thought to be those that spend extended periods at the surface or species whose unresponsiveness to vessel sound makes them more susceptible to vessel collisions (Gerstein 2002; Laist and Shaw 2006; Nowacek et al. 2004a). Marine mammals such as dolphins, porpoises, and pinnipeds that can move quickly throughout the water column are not as susceptible to vessel strikes.

Information available on the species of cetaceans involved in vessel strikes in the Study Area comes from the National Marine Fisheries Service, Northeast Science Center and Southeast Science Center (unpublished data 1995-2011). These data are from all types of vessels (Navy, commercial and recreational), but give an indication of which species are vulnerable to ship strike in the Study Area. Out of 113 reported strikes the percentage of strikes by species is as follows: humpback whale (28 percent), North Atlantic right whale (19 percent), fin whale (17 percent), unknown species (16 percent), sei whale (6 percent), minke whale (5 percent), Cuvier's beaked whale (3 percent), Bryde's whale (2 percent), sperm whale (2 percent), Blainville's beaked whale (1 percent), and Gervais' beaked whale (1 percent). West Indian manatees are highly susceptible to boat strikes. In the state of Florida alone, 169 watercraft-related deaths were reported in 2011-2012. As the result of consultation with the U.S. Fish and Wildlife Service and implementation of mitigation measures implemented in 1991, which have been supplemented in subsequent years, there has not been any incident that resulted in injury or mortality of a manatee due to naval activities or operations. Data and information specific to the occurrence and impact of vessel strikes to a species or group are further summarized in the following sections.

3.4.3.3.1.1 Mysticetes

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 and Taggart 2008). Some individuals may become habituated to low-frequency sounds from shipping and fail to respond to an approaching vessel (National Marine Fisheries Service 2008a). 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). Because surface activity includes feeding, breeding, and resting, whales may be engaged in this activity and not notice an approaching vessel (Silber and Bettridge 2010). Even if they were to hear the vessel, most mysticetes generally move too slowly to avoid vessels approaching at high speeds.

Based on NMFS vessel strike data (unpublished data 1995-2012), humpback whales, North Atlantic right whales, and fin whales are the three species with the highest percentage of reported strikes in the AFTT Study Area (Laist et al. 2001; Waring et al. 2010). Vessels strikes are a threat to these species, as well as sei and blue whales, because of their surface or near-surface feeding behaviors (Waring et al. 2010). Some areas in the Northeast Range Complexes are important feeding areas to these species in the summer months, so strike risk would be higher while these whales are on the feeding grounds.

Vessel strikes are considered a primary threat to North Atlantic right whale survival (Firestone 2009; Fonnesbeck et al. 2008; Knowlton and Brown 2007; Nowacek et al. 2004a; Vanderlaan et al. 2009; Vanderlaan et al. 2008). Studies of North Atlantic right whales tagged in April 2009 on the Stellwagen Bank feeding grounds found that right whales spent most of their time at a depth of 6.5 ft. (2 m), which makes them less visible at the water's surface (Bocconcelli 2009; Parks and Wiley 2009). The Navy will continue to implement mitigation measures in important North Atlantic right whale foraging, calving, and migration habitats. These measures, include increasing awareness, the use of sighting advisory systems, and providing specialized training on North Atlantic right whale observation, and are detailed in Chapter 5, Standard Operating Procedures, Mitigation Measures, and Monitoring. These measures will likely reduce the risk of a strike to the point that a strike of this species is not likely to occur, and will likely reduce the overall risk of strike to all other mysticetes.

3.4.3.3.1.2 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 and Fertl 2000), short-finned and long-finned pilot whales (Aguilar et al. 2000; Van Waerebeek et al. 2007), bottlenose dolphin (Bloom and Jager 1994; Van Waerebeek et al. 2007; Wells and Scott 1997), white-beaked dolphin (Van Waerebeek et al. 2007), short-beaked common dolphin (Van Waerebeek et al. 2007), spinner dolphin (Camargo and 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 to restore oxygen levels within their tissues after deep dives (Jaquet and Whitehead 1996; Watkins et al. 1999).

3.4.3.3.1.3 Pinnipeds

From the limited data available, it appears that pinnipeds in general appear to suffer fewer impacts from vessel strikes than cetaceans or sirenians. 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. A review of seal stranding data from Cape Cod, Massachusetts found that from 1999 to 2004, 622 pinniped strandings were recorded by the Cape Cod Stranding Network. Of these 622 strandings, 11 (approximately 2 percent) were found to be caused by boat collisions (Swails 2005).

3.4.3.3.1.4 Polar Bears

Richardson et al. (1995) reported that polar bears generally show little reaction (and these tend to be short-term and localized) from shipping traffic. Polar bears spend a large amount of their time on pack ice or land (Monnett and Gleason 2006), where they would not be vulnerable to vessel strikes.

3.4.3.3.1.5 West Indian Manatees

West Indian manatees respond to vessel movement via acoustic and possibly visual cues by moving away from the approaching vessel, increasing its swimming speed, and moving toward deeper water (Miksis-Olds et al. 2007; Nowacek et al. 2004b). The degree of the response varies with the individual manatee and may be more pronounced in deeper water where they are more easily able to locate the direction of the approaching vessel (Nowacek et al. 2004b). This disturbance is a temporary response to the approaching vessel. West Indian manatees have also been shown to seek out areas with a lower density of vessels (Buckingham et al. 1999). West Indian manatees exhibit a clear behavioral response to vessels within distances of 82 to 164 ft. (25 to 50 m), but it is unclear at what distance the manatees first detect the presence of vessels (Nowacek et al. 2004b). Vessel traffic and recreation activities that disturb West Indian manatees may cause them to leave preferred habitats and may alter biologically important behaviors such as feeding, suckling, or resting (Haubold et al. 2006).

In addition to disturbance, West Indian manatees are particularly susceptible to vessel collisions (both collisions with the hull and propeller strikes) because they hover near the surface of the water, move very slowly, and spend most of their time in coastal waters where vessel traffic tends to be more concentrated (Calleson and Frohlich 2007; Gerstein 2002; Haubold et al. 2006; Runge et al. 2007; U.S. Fish and Wildlife Service 2007). Vessel strikes are the direct agent of most human-caused deaths to adult West Indian manatees (Rommel et al. 2007; U.S. Fish and Wildlife Service 2007), accounting for approximately 25 percent of all manatee deaths recorded in Florida since 1976 (Calleson and Frohlich 2007). Though 98 percent of the registered watercraft in Florida are less than or equal to 40 ft. (12.2 m) in length, the analysis of a five-year subset of historical mortality data suggests that a disproportionate number of propeller-caused watercraft-related mortalities could be attributed to propeller diameters greater than or equal to 17 in. (43.2 cm), inferring that these were caused by watercraft greater than 40 ft. (12.2 m) (Rommel et al. 2007). U.S. Fish and Wildlife Service indicates that manatees are probably struck by smaller watercraft more often, but the likelihood of mortality is dependent on the force of collision, which is a factor of the speed and size of the vessel.

Not all collisions are fatal, as evidenced by the fact that most West Indian manatees in Florida bear scars from previous boat strikes (Rommel et al. 2007). However, nonlethal injuries may reduce the breeding success of females (Haubold et al. 2006) and may lower a manatee's immune response (Halvorsen and Keith 2008). Manatees generally occur in a very limited portion of the Study Area, primarily in the coastal waters off the southeastern United States and the Gulf coast of Florida.

3.4.3.3.1.6 No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative)

Section 3.0.5.3.3.1 (Vessels) provides estimates of relative vessel use and location for each of the alternatives. This section provides an estimated number of events predicted for each alternative. While these provide a prediction of vessel use, actual Navy vessel usage depends on military training requirements, deployment schedules, annual budgets, and other unpredictable factors. Training and testing concentrations are most dependent on locations of Navy shore installations and established testing and training areas. Even with the introduction of the Undersea Warfare Training Range, the areas where the Navy primarily transits has not appreciably changed in the last decade and are not expected to change in the foreseeable future. Under Alternatives 1 and 2, the Study Area would be expanded from the No Action Alternative and the number of events may increase, but the concentration of vessel use and the manner in which the Navy trains and tests is not expected to change, but would remain consistent with the range of variability observed over the last decade. This is partly because multiple activities occur from the same vessel platform. Therefore, the increased number activities estimated for Alternatives 1 and 2 is not expected to result in an increase in vessel use or transit. 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 strikes are expected to occur is likely to remain consistent with the previous decade or be reduced because of the implementation of mitigation measures as outlined in Chapter 5, Standard Operating Procedures, Mitigation Measures and Monitoring. The difference in events from the No Action Alternative to Alternative 1 and Alternative 2, shown in Section 3.0.5.3.3.1 (Vessels), is not likely to change the probability of a vessel strike in any meaningful way.

Training Activities

As indicated in Section 3.0.5.3.3.1 (Vessels), most training activities involve the use of vessels. 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 Study Area but for the most part occur within the established range complexes, and are more concentrated near naval ports, piers, and range areas. Navy training vessel traffic would especially be concentrated near Naval Station Norfolk in Norfolk, Virginia, in the Northeast U.S. Continental Shelf Large Marine Ecosystem and near Naval Station Mayport in Jacksonville, Florida, in the Southeast U.S. Continental Shelf Large Marine Ecosystem. Refer to Section 3.0.5.3.3.1 (Vessels) for the estimated vessel use by range area.

Large vessel movement primarily occurs within the U.S. Exclusive Economic Zone, with the majority of the traffic flowing in a direct line between Naval Stations Norfolk and Mayport. The direct route the Navy predominantly uses between Norfolk and Jacksonville avoids a good portion of the coastal North Atlantic right whale migratory corridor and critical habitat, especially off the coasts of South Carolina and Georgia. There would be a higher likelihood of vessel strikes over the continental shelf portions than in the open ocean portions of the Study Area because of the concentration of vessel movements in those areas. There is not expected to be any predictable seasonal differentiation in Navy vessel use.

Support craft would be more concentrated in the coastal areas near naval installations, ports, and ranges. Training activities involving the use of support craft in the coastal, shallow water areas where manatees are likely to occur are limited to a few types of events, including mine neutralization, search and rescue, special warfare and force protection. Navy vessels comply with all federal, state and local Manatee Protection Zones, and vessels reduce speed in accordance with established safety procedures. Where manatees are most likely to be encountered, the Navy has established specific procedures. Section 5.3.3.1.2 (West Indian Manatee) in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) provides a list of the applicable procedures.

The concentration of vessel use and the manner in which the Navy trains is expected to be consistent with the range of variability observed over the last decade. Therefore, historical strike data were used to calculate the probability of a Navy vessel striking a whale during proposed training activities in the Study Area. In the AFTT Study Area, there were a total of 20 reported whale strikes from January 1995–May 2013, for an average of 1.086 per year (20 strikes/18.42 years =1.086). These values were used as the rate parameter 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). To estimate the Poisson probabilities of 1, 2, 3, 4, 5, etc. occurrences, a simple computation can be generated: $P(X) = P(X-1)\mu/X$.

$P(X)$ is the probability of occurrence in a unit of time (or space), and μ is the mean number of occurrences in a unit of time (or space). For the period from January 1995–May 2013, μ is calculated as 1.086.

To estimate zero occurrences (in this case, no whales being struck), the formula $P(0)=e^{-\mu}$ would apply. Plugging 1.086 into the equation yields a value of $P(0) = 0.3376$, hence the statement “there is slightly less than a 64 percent probability of a large whale of any species not being struck by a Navy vessel in the Study Area.” Thus, continuing the computation series:

- P(1) = (0.3376 * 1.086)/1 = 0.3666 (or a 37 percent probability of striking one whale in 1 year)
- P(2) = (0.3673 * 1.086)/2 = 0.1991 (or a 20 percent probability of striking two whales in 1 year)
- P(3) = (0.1938 * 1.086)/3 = 0.0721 (or a 7 percent probability of striking three whales in 1 year)
- P(4) = (0.0681 * 1.086)/4 = 0.0196 (or a 2 percent probability of striking four whales in 1 year)
- P(5) = (0.0180 * 1.086)/5 = 0.0042 (or a 0.4 percent probability of striking five whales in 1 year)

While the Poisson distribution shows that the probability of striking three or more whales in a single year is low (7 percent chance), it did occur in 2001 and 2004. When averaging the available data over five-year increments, the highest average over a period for which data are available is two strikes per year.

Based on available NMFS data (unpublished data 1995-2012) and a consideration of mitigation measures discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring), the Navy predicts that the fin whale, humpback whale, minke whale, sei whale, Bryde's whale, sperm whale, blue whale, Blainville's beaked whale, Cuvier's beaked whale, Gervais' beaked whale, and unidentified whale species have the potential to be struck by a vessel as a result of training activities in the Study Area. Most Navy-reported whale strikes are not identified to species; therefore, the Navy cannot quantifiably predict that the proposed takes will be of any particular species. Consequently, the Navy is seeking take authorization for a combination of the following species: fin whale, humpback whale, minke whale, sei whale, Bryde's whale, sperm whale, blue whale, Blainville's beaked whale, Cuvier's beaked whale, Gervais' beaked whale, and unidentified whale species under the Preferred Alternative (Alternative 2). The Navy estimates it may strike and take, by injury or mortality, an average of two marine mammals per year, with a maximum of three in any given year. Of the ESA-listed species in the Study Area, the Navy anticipates no more than three humpback whales and two fin whales, one sei whale, one blue whale and one sperm whale could be struck over a five-year period based on the percentages that those species have been involved in vessel collisions.

The Navy does not anticipate it will strike a North Atlantic right whale because of the extensive measures in place to reduce the risk of a strike to that species. Vessel use may occur within the North Atlantic right whale’s designated critical habitat areas year round. It is possible that North Atlantic right whales encountered could be disturbed by the presence of vessels. Disturbance within the southeast critical habitat is mostly likely to occur in winter months and during summer months within the Northeast critical habitat. Physical disturbance from vessel use is not expected to result in more than a momentary behavioral response.

The primary constituent elements of the habitat required by North Atlantic right whales for feeding and breeding have been reported as the presence of copepods in the Northeast (Pace 2008) and water temperature and depth in the Southeast (Garrison 2007); however, these primary constituent elements are not expected to be impacted by vessels.

The Navy does not anticipate it will strike a manatee. Manatees generally occur in a very limited portion of the Study Area, primarily in the coastal waters off the southeastern United States and the Gulf coast of Florida. Where manatees are most likely to be encountered, mitigation measures are in place. Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) provides a full list of these procedures. Specifically within the basin and associated channels at Naval Station Mayport in Jacksonville, Florida, Navy vessels comply with all federal, state, and local Manatee Protection Zones, and vessels reduce speed in accordance with established safety procedures.

At Naval Submarine Base Kings Bay in Kings Bay, Georgia, C-Tractor tugs and all other applicable support boats operating have been retrofitted with manatee guards (U.S. Department of the Navy 2008), which according to the U.S. Fish and Wildlife Service has eliminated this source of mortality at Naval Submarine Base Kings Bay (U.S. Fish and Wildlife Service 2001). In addition, Naval Submarine Base Kings Bay also has an operational instruction that requires the use of Lookouts onboard all Navy vessels operating in port waters to reduce the risk of collision with manatees. Similar protective measures are in place at Naval Station Mayport in Jacksonville, Florida, including small craft vessels with manatee guards, speed restrictions, a manatee notification protocol to report sightings in the basin to Harbor Operations, and manatee awareness training for personnel.

The Navy does not anticipate that vessel transit will injure any manatees as they only occur in a very limited portion of the Study Area, primarily in the coastal waters off the southeastern United States and the Gulf coast of Florida, where vessel use is limited to only a few activities. The use of an Early Warning Communication System and idle speed regulations are in place at Kings Bay, Georgia, further reducing potential impacts. The low probability of vessel co-occurrence and the use of mitigation measures around Kings Bay, Georgia and Jacksonville, Florida, indicate that the likelihood of a strike is very low. Physical disturbance from vessels is not expected to result in more than a momentary behavioral response. Manatees also occur in the coastal waters of Puerto Rico, which is within the Study Area, but no training is anticipated in these areas where manatees would occur.

Vessel use may occur in very small portions of the West Indian manatee designated critical habitat near Mayport and Port Canaveral, Florida year round. It is possible that manatees could be disturbed by the presence of vessels in any portion of the Study Area. Disturbance within manatee habitat is mostly likely to occur during spring, summer, or fall, because during winter they generally move farther inland. Physical disturbance from vessels is not expected to result in more than a momentary behavioral response. The primary constituent elements of the habitat required by the West Indian manatee for feeding and breeding have been reported as the presence of seagrass foraging habitat and warm water refuges. These elements would not be impacted by vessel use during training activities within the designated critical habitat.

While it is possible that during training activities, vessels could transit outside of the established range complexes where bowhead whales, ringed seals, or polar bears occur, these transits are expected to be very infrequent; therefore, the Navy does not anticipate it will disturb or strike these species.

Pursuant to the MMPA, *the use of vessels during training activities under the No Action Alternative, Alternative 1, or Alternative 2:*

- *may result in up to 10 Level A harassment or mortality takes of any of the following species over the next 5-year period): the fin whale, humpback whale, minke whale, sei whale, Bryde's whale, sperm whale, blue whale, Blainville's beaked whale, Cuvier's beaked whale, Gervais' beaked whale, or unidentified whale species and*
- *is not expected to result in Level B harassment of marine mammals.*

Pursuant to the ESA, the use of vessels during training activities as described in the No Action Alternative, Alternative 1, or Alternative 2:

- *may affect and is likely to adversely affect the ESA-listed humpback whale, sei whale, fin whale, blue whale and sperm whale;*
- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, bowhead whale, ringed seal, polar bear, and West Indian manatee; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

Testing Activities

As indicated in Section 3.0.5.3.3.1 (Vessels), most of the testing activities involve the use of vessels. However, the number of activities that include the use of vessels for testing is comparatively lower (around 10 percent) 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 naval ports, piers, range complexes, testing ranges, and especially off the northeast U.S. coast, off south Florida, and in the Gulf of Mexico. 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, also referred to as high-speed vessel trials, occur infrequently but pose a higher strike risk because of the high speeds at which the vessels need to transit to complete the testing activity. These activities would most often occur in the Gulf of Mexico Large Marine Ecosystem in the Gulf of Mexico, but may also occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem in the Northeast Range Complexes, the Gulf Stream Open Ocean Area, and the North Atlantic Gyre Open Ocean Area in the VACAPES and JAX Range Complexes. However, there are just a few of these events proposed per year, so the increased risk is nominal compared to all vessel use in the Proposed Action.

The marine mammal species primarily at risk would be large whales in the Gulf of Mexico and Southeast U.S. Large Marine Ecosystems. Of the 20 reported Navy vessel strikes since 1995, only one strike was attributed to a testing event in 2001. Therefore, for testing events that will not occur on a training platform, the Navy estimates it may take a single marine mammal, by injury or mortality over the next five-year period. Because of the number of incidents in which the struck animal has remained unidentified to species, the Navy cannot quantifiably predict that the proposed takes will be of any particular species and therefore seeks take authorization for any the following species: fin whale, humpback whale, minke whale, sei whale, Bryde's whale, sperm whale, blue whale, Blainville's beaked whale, Cuvier's beaked whale, Gervais' beaked whale, or unidentified whale species. The Navy’s vessel operating procedures are designed to reduce the potential for strikes and to ensure the safety of the vessel and crew; Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) provides a full list of these procedures.

The Navy does not anticipate it will strike a North Atlantic right whale because of the extensive measures in place to reduce the risk of a strike to that species. Vessel use may occur within the North Atlantic right whale designated critical habitat areas year round. As discussed above in the training activities discussion, it is possible that right whales encountered in these areas may be disturbed by the presence of vessels. Disturbance within the Southeast critical habitat is most likely to occur in winter, and during summer within the northeast critical habitat. As discussed above in the training activities discussion, primary constituent elements of North Atlantic right whale critical habitat are not expected to be impacted.

The Navy does not anticipate that vessel transit will injure any manatees during testing activities as manatees generally occur in a very limited portion of the Study Area, primarily in the coastal waters off the southeastern United States and the Gulf coast of Florida. Within these areas, there are just a few testing activities that occur close to shore where manatees would be likely to be encountered. In addition, there are mitigation measures in place (as described above under Training Activities) which make the likelihood of a strike very low. Disturbance is mostly likely to occur during spring, summer, or fall, because during winter manatees generally move farther inland. Physical disturbance from vessel use is not expected to result in more than a momentary behavioral response.

As discussed above in the training activities discussion, vessel use may occur in very small portions of the West Indian manatee designated critical habitat. The primary constituent elements of the habitat required by the West Indian manatee for feeding and breeding have been reported as the presence of seagrass foraging habitat and warm water refuges. These elements would not be impacted by vessel use during testing activities within the designated critical habitat.

While it is possible that during testing activities, vessels could transit outside of the established range complexes where bowhead whales, ringed seals, or polar bears occur, these transits are expected to be very infrequent; therefore, the Navy does not anticipate it will disturb or strike these species.

Pursuant to the MMPA, the use of vessels during testing activities as described under the No Action Alternative, Alternative 1, or Alternative 2:

- *may result in Level A harassment or mortality of a fin whale, humpback whale, minke whale, sei whale, Bryde's whale, sperm whale, blue whale, Blainville's beaked whale, Cuvier's beaked whale, Gervais' beaked whale, or unidentified whale species and*
- *is not expected to result in Level B harassment of marine mammals.*

Pursuant to the ESA, the use of vessels during testing activities as described under the No Action Alternative, Alternative 1, or Alternative 2:

- *may affect and is likely to adversely affect the ESA-listed humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, bowhead whale, ringed seal, polar bear, and West Indian manatee; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.3.2 Impacts from In-Water Devices

In-water devices are generally smaller (several inches to 111 ft. [34 m]) than most Navy vessels. Section 3.0.5.3.3.2 (In-Water Devices) discusses the types of activities that use in-water devices, where they are used, and how many events will occur under each alternative.

Devices that could pose a collision risk to marine mammals are those operated at high speeds and are unmanned. These are mainly limited to the unmanned surface vehicles such as high-speed targets and unmanned underwater vehicles. 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 acoustic homing programs of U.S. Navy torpedoes are sophisticated and would not confuse the acoustic signature of a marine mammal with a submarine/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 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 from a torpedo or any other in-water device.

Since some in-water devices are identical to support craft, marine mammals could respond to the physical presence of the device as discussed in Section 3.4.3.3.1 (Impacts from Vessels). Physical disturbance from the use of in-water devices is not expected to result in more than a momentary behavioral response.

Devices such as unmanned underwater vehicles that move slowly through the water are highly unlikely to strike marine mammals because the mammal could easily avoid the object. Towed devices are unlikely to strike a marine mammal because of the mitigation measures that involve Lookouts observing within a mitigation zone when towing in-water devices.

The Navy does not anticipate encountering a manatee during the use of in-water devices during training activities, as manatees generally occur in a very limited portion of the Study Area, primarily in the coastal waters off the southeastern United States and the Gulf coast of Florida. Within these areas, there are just a few training activities that may involve the use of in-water devices that may occur close to shore where manatees would likely be encountered. In addition, there are mitigation measures in place for towed devices which make the likelihood of a strike very low. Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) provides a full list of these mitigation measures.

In-water devices are not anticipated to be used where bowhead whales, ringed seals, or polar bears occur. Therefore, these species are not expected to be affected by the Navy's in-water device use in the Study Area.

3.4.3.3.2.1 No Action Alternative, Alternative 1 and Alternative 2 (Preferred Alternative)

Training

In-water device use could occur in the portions of the Study Area listed in Section 3.0.5.3.3.2 (In-Water Devices) at any time of year. Unmanned surface vehicle use would be concentrated within the Northeast U.S. Continental Shelf Large Marine Ecosystem in the VACAPES Range Complex, within the Southeast U.S. Continental Shelf Large Marine Ecosystem in the Navy Cherry Point and JAX Range Complexes, and within the Gulf of Mexico Large Marine Ecosystem in the GOMEX Range Complex.

As discussed above, in Section 3.4.3.3.2 (Impacts from In-Water Devices), some marine mammal species may encounter in-water devices. However, for the reasons discussed, in-water devices are not likely to strike a marine mammal. It is possible that marine mammals 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 momentary behavioral response.

The Navy does not anticipate encountering a manatee during the use of in-water devices during training activities, as manatees generally occur in a very limited portion of the Study Area, primarily in the coastal waters off the southeastern United States and the Gulf coast of Florida. Within these areas, there are just a few training activities that may involve the use of in-water devices that may occur close to shore where manatees would likely be encountered. In addition, there are mitigation measures in place for towed devices, which make the likelihood of a strike very low. Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) provides a full list of these mitigation measures.

In-water device use may occur within the North Atlantic right whale's designated critical habitat areas year-round. Potential disturbance within the southeast critical habitat is mostly likely to occur in winter, and during summer within the northeast critical habitat. The primary constituent elements of the habitat required by North Atlantic right whales for feeding and breeding have been reported as the presence of copepods in the northeast (Pace and Merrick 2008) and water temperature and depth in the southeast (Garrison 2007); however, these primary constituent elements are not expected to be impacted. In-water device use is not expected to occur in West Indian manatee critical habitat.

Pursuant to the MMPA, the use of in-water devices during training activities as described under the No Action Alternative, Alternative 1, or Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of in-water devices during training activities as described under the No Action Alternative, Alternative 1, or Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

Testing

In-water device use could occur in the portions of the Study Area listed in Section 3.0.5.3.3.2 (In-Water Devices) at any time of year. Unmanned surface vehicle use would be concentrated within the Northeast U.S. Continental Shelf Large Marine Ecosystem in Narragansett Bay; the Naval Undersea Warfare Center Division, Newport Testing Range; and the VACAPES Range Complex. Within the Southeast U.S. Continental Shelf Large Marine Ecosystem, use would be concentrated in the JAX Range Complex.

As discussed above, in Section 3.4.3.3.2 (Impacts from In-Water Devices), some marine mammal species may encounter in-water devices. However, for the reasons discussed, in-water devices are not likely to strike a marine mammal. It is possible that marine mammals 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 momentary behavioral response.

The Navy does not anticipate encountering a manatee during the use of in-water devices during testing activities, as manatees generally occur in a very limited portion of the Study Area, primarily in the coastal waters off the southeastern United States and the Gulf coast of Florida. Within these areas, there are just a few testing activities that may involve the use of in-water devices that may occur close to shore where manatees would likely be encountered. In addition, there are mitigation measures in place, which make the likelihood of a strike very low. Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) provides a full list of these mitigation measures.

In-water device use may occur within the North Atlantic right whale's designated critical habitat areas year-round Potential disturbance within the southeast critical habitat is mostly likely to occur in winter, and during summer within the northeast critical habitat. The primary constituent elements of the habitat required by North Atlantic right whales for feeding and breeding have been reported as the presence of copepods in the northeast (Pace and Merrick 2008) and water temperature and depth in the southeast (Garrison 2007); however, these primary constituent elements are not expected to be impacted. In-water device use is not expected to occur in West Indian manatee critical habitat.

Pursuant to the MMPA, the use of in-water devices during testing activities as described under the No Action Alternative, Alternative 1, or Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of in-water devices during testing activities as described under the No Action Alternative, Alternative 1, or Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.3.3 Impacts from Military Expended Materials

This section analyzes the strike potential to marine mammals from the following categories of military expended materials: (1) non-explosive practice munitions, (2) fragments from high-explosive munitions, and (3) expended materials other than munitions, such as sonobuoys, expendable targets and aircraft stores (fuel tanks, carriages, dispensers, racks, carriages, or similar types of support systems on aircraft that could be expended or recovered). Section 3.0.5.3.3.3 (Military Expended Materials) discusses the types of activities that use military expended materials, where they are used, and how many events will occur under each alternative.

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 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 the likelihood. Specific details of the modeling approach including model selection and calculation methods can be found in Appendix G (Statistical Probability Analysis for Estimating Direct Strike Impact and Number of Potential Exposures).

To estimate the likelihood of a strike, the highest probability of a strike was calculated by using the marine mammal with the highest average density in areas with the highest military expended material expenditures. These highest estimates would then provide a point of comparison for all other areas and species. The areas with the greatest amount of expended materials are expected to be the Northeast U.S. Continental Shelf Large Marine Ecosystem, the Southeast U.S. Continental Shelf Large Marine Ecosystem, and the Gulf Stream Open Ocean Area (specifically within the VACAPES and JAX Range Complexes). 3.0.5.3.3.3 (Military Expended Materials) provides estimates of expended materials throughout the entire Study Area.

For all the remaining marine mammals with lesser densities, this highest likelihood would overestimate the likelihood or probability of a strike. Because the ESA has specific standards for understanding the likelihood of impacts on each endangered species, estimates are provided for all endangered marine mammals. These estimates were also calculated with the highest average mammal densities and 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 annual total impact of all military expended materials with the potential to strike a marine mammal was calculated each of the 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 and 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 would be much 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. The risk of the West Indian manatee to be exposed to this stressor during training events is highly unlikely because its primarily inland/coastal distribution does not overlap the offshore areas where the Navy generally conducts the types of activities that expend these materials. Manatees may be exposed to this stressor in the Gulf of Mexico during testing events conducted in the nearshore environment, though they are very rarely encountered in those areas.

Species such as the bowhead whale and polar bear whose ranges are outside of the areas where these materials would be normally be expended are not likely to be exposed to this stressor. The primary constituent elements of the habitat required by North Atlantic right whales and West Indian manatees, as described previously, would not be impacted by military expended materials.

The model output provides a reasonably high level of certainty that marine mammals would not be struck by military expended materials. Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) describes mitigation measures proposed to help further reduce the potential impacts of military expended material strikes on marine mammals.

3.4.3.3.3.1 No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative) – Training Activities

The model results presented in Table 3.4-36 present the probability of a strike as percent. The results indicate with a reasonable level of certainty that marine mammals would not be struck by non-explosive practice munitions and expended materials other than munitions. Results range from zero, or a zero percent chance that a North Atlantic right whale would be struck by any military expended material, to a 4 percent chance that a spotted dolphin may be struck by any military expended material over the course of a year. However, as discussed above, this does not take into account the assumptions that likely overestimate impact probability and the behavior of marine mammals (e.g., spotted dolphins travel in groups and are relatively easy to spot), which would make the risk of a strike even lower. Alternatives 1 and 2 have an increased amount of expended materials from training activities compared to the No Action Alternative, as shown in Section 3.0.5.3.3.3 (Military Expended Materials). The increase in expended materials and a proposed expansion of the Study Area from the No Action Alternative to Alternatives 1 and 2 result in a corresponding increase of the risk of a strike, as shown in Table 3.4-36. While the Study Area is expanded under Alternatives 1 and 2, species such as the bowhead whale and polar bear ranges are outside of the areas where these materials would be expended under Alternatives 1 and 2 and are not likely to be exposed to this stressor.

Table 3.4-36: Probability of a Military Expended Material Strike for Representative Marine Mammals by Area and Alternative

Northeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area						
VACAPES Range Complex						
Species	Training			Testing		
	No Action	Alternative 1	Alternative 2	No Action	Alternative 1	Alternative 2
North Atlantic Right Whale	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Humpback Whale	0.00%	0.01%	0.01%	0.01%	0.01%	0.01%
Sei Whale	0.02%	0.05%	0.05%	0.04%	0.06%	0.06%
Fin Whale	0.01%	0.03%	0.03%	0.03%	0.04%	0.05%
Blue Whale	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Sperm Whale	0.08%	0.18%	0.18%	0.16%	0.23%	0.25%
Atlantic Spotted Dolphin	1.84%	4.42%	4.42%	3.76%	5.69%	6.01%
Southeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area						
JAX Range Complex						
Species	Training			Testing		
	No Action	Alternative 1	Alternative 2	No Action	Alternative 1	Alternative 2
North Atlantic Right Whale	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Humpback Whale	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Sei Whale	0.01%	0.02%	0.02%	0.00%	0.00%	0.00%
Fin Whale	0.00%	0.01%	0.01%	0.00%	0.00%	0.00%
Blue Whale	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Sperm Whale	0.01%	0.02%	0.02%	0.00%	0.01%	0.01%
Atlantic Spotted Dolphin	0.45%	0.94%	0.94%	0.15%	0.25%	0.28%

JAX: Jacksonville; VACAPES: Virginia Capes; %: percent

Proposed training activities involving the use of military expended materials do not overlap with bowhead whale, ringed seal, or polar bear habitat.

Pursuant to the MMPA, the use of military expended materials during training activities as described under the No Action Alternative, Alternative 1, or Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of military expended materials for training activities as described under the No Action Alternative, Alternative 1, or Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right, humpback, sei, fin, blue, and sperm whales and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.3.3.2 No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative) – Testing Activities

The model results presented in Table 3.4-36 indicate a reasonable level of certainty that marine mammals would not be struck by non-explosive practice munitions and expended materials other than munitions. Results range from zero, or a zero percent chance that a North Atlantic right whale would be struck by any military expended material to a 6 percent chance that a spotted dolphin may be struck by any military expended material over the course of a year. However, as discussed above, this does not take into account the assumptions that likely overestimate impact probability and the behavior of marine mammals (e.g., spotted dolphins travel in groups and are relatively easy to spot), which would make the risk even lower. Alternatives 1 and 2 have an increased amount of expended materials from testing activities compared to the No Action Alternative, as shown in Section 3.0.5.3.3.3 (Military Expended Materials). The increase in expended materials and a proposed expansion of the Study Area from the No Action Alternative to Alternatives 1 and 2 may result in a corresponding increase of the risk of a strike, as shown in Table 3.4-36. While the Study Area is expanded under Alternatives 1 and 2, species such as the bowhead whale and polar bear occur outside of the areas where these materials would be expended under Alternatives 1 and 2, and are not likely to be exposed to this stressor.

Proposed testing activities that involve the use of military expended materials do not overlap with bowhead whale, ringed seal, or polar bear habitat.

Pursuant to the MMPA, the use of military expended materials during testing activities as described under the No Action Alternative, Alternative 1, or Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of military expended materials for testing activities as described under the No Action Alternative, Alternative 1, or Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, and West Indian manatee;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.3.4 Impacts from Seafloor Devices

Section 3.0.5.3.3.4 (Seafloor Devices) discusses the types of activities that use seafloor devices, where they are used, and how many events will occur under each alternative. 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. As discussed in Section 3.4.3.3.3 (Impacts from Military Expended Materials), objects falling through the water column will slow as they sink toward the bottom and could be avoided by most 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 considered in the military expended material strike analysis (Section 3.4.3.3.3, Impacts from Military Expended Materials).

The primary constituent elements of the habitat required by North Atlantic right whales and West Indian manatees, as described previously, would not be impacted by seafloor devices.

Proposed activities involving the use of seafloor devices do not overlap with bowhead whale, ringed seal, or polar bear habitat.

Pursuant to the MMPA, the use of seafloor devices during training and testing activities as described under the No Action Alternative, Alternative 1, or Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of seafloor devices during training and testing activities as described under the No Action Alternative, Alternative 1, or Alternative 2:

- *will have no effect on ESA-listed bowhead whale, North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, sperm whale, ringed seal, polar bear and West Indian manatee; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.4 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 two types of military expended materials: (1) fiber optic cables and guidance wires and (2) parachutes. 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 3.0.5.3.4 (Entanglement Stressors). This section does not analyze impacts on critical habitat because Section 3.4.3.3.3 (Impacts from Military Expended Materials) already analyzed the potential impacts of expended materials on designated critical habitat.

These materials may have the potential to entangle and could be encountered by marine mammals in the Study Area at the surface, in the water column, or along the seafloor, though the properties and size of these items makes entanglement unlikely. In addition, there has never been a reported or recorded instance of a marine mammal entangled in military expended materials; however, the possibility still exists. 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.

3.4.3.4.1 Mysticetes

Mysticetes, like all marine mammals, are susceptible to becoming entangled in floating debris. They may be especially vulnerable when they lunge feed at the surface (Derraik 2002). Entanglement of many large whales, including the North Atlantic right whale (a species that shows scars in almost every individual from entanglements with lobster trap lines) most often begins with rope being caught in its baleen plates. Trailing lengths of rope then become wrapped around the animal’s appendages as it struggles to free itself (Kozuck 2003). In the western North Atlantic, 41 percent of all documented entangled humpbacks were entangled in crab pots and 50 percent in gillnets (Nielsen 2009). In a study of humpback whales in northern southeast Alaska, the percentage of whales thought to have been non-lethally entangled in their lifetimes based on scarring ranged between 52 and 78 percent (Nielsen 2009). Available data indicate males typically have more scars than females and may become entangled more frequently. Juvenile humpback whales and North Atlantic right whales in the western North Atlantic were found to have a higher rate of entanglement and be more at risk of serious injury when entangled than mature animals (Robbins 2009, 2010). Entanglement is more likely for animals that feed on the bottom (humpback and possibly fin whales).

3.4.3.4.2 Odontocetes

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 whales likely became entangled while feeding along the bottom, as the cables were most often found wrapped around the jaw. Juvenile harbor porpoises exposed to 0.5 in. diameter (13 millimeters [mm] diameter) white nylon ropes in both vertical and horizontal planes treated the ropes as barriers, more frequently swimming under than over them. However, porpoises feeding on fish in the area crossed the ropes more frequently and became less cautious, suggesting that rope poses a greater risk in a feeding area than in a transit area. For porpoises feeding on the bottom, rope suspended near the seafloor is more likely to entangle than rope higher in the water column because the animals' natural tendency is to swim beneath barriers (Kastelein 2009).

3.4.3.4.3 Pinnipeds

Fur seals appear to be attracted to floating debris and consequently suffer a high rate of entanglement in derelict fishing lines and nets (Derraik 2002) than other pinniped species. Their unique habit of rolling on the surface of the water leads to complex entanglement. 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). Other species of seals, such as harbor seals, gray seals, and harp seals can also get entangled in nets and fishing line when young and then grow with the lines wrapped around their necks or appendages, causing deep wounds and eventually death.

The primary constituent elements of the habitat required by North Atlantic right whales and West Indian manatees, as described previously, would not be impacted by cables, wires or parachutes.

3.4.3.4.4 Impacts from Fiber Optic Cables and Guidance Wires

Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires) discusses the types of activities that use cables and wires, where they are used, and how many events will occur under each alternative. This section does not analyze impacts on critical habitat because Section 3.4.3.3.3 (Impacts from Military Expended Materials) already analyzed the potential impacts of expended materials on designated critical habitat.

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. 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. The length of the cable varies (up to about 900 ft. [3,000 m]), and greater lengths may 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 cables will be available for longer periods. 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 Study Area limits the potential for encounters. The physical characteristics of the fiber optic material render the cable brittle and easily broken when kinked, twisted, or bent sharply (i.e., to a radius greater than 360 degrees). Thus, the physical properties of the fiber optic cable would not allow the cable to loop, greatly reducing or eliminating any potential issues of entanglement with regard to marine life.

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 sea floor. 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 0.7 ft. [0.2 m] per second), it is most likely that a marine mammal would only encounter a guidance wire once it had settled on the sea floor. 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. 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, 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 Study Area limits the potential for encounters.

Marine mammal species that occur within the Study Area were evaluated based on the likelihood of encountering these items. Mysticete species that occur where these training and testing activities take place could encounter these items once they settle to the seafloor if they feed on the bottom in the areas where these activities occur. Although manatees may occur in these areas, these training and testing activities would not take place in shallow waters where manatees would be feeding and therefore potentially encounter these items on the seafloor. Odontocete and pinniped species, which occur in these areas and that forage on the bottom, could potentially encounter these items. The bowhead whale, narwhal, beluga whale, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear do not occur in these areas.

The chance that an individual animal would encounter expended cables or wires is most likely low based on the distribution of both the cables and wires expended, the fact that the wires and cables will sink upon release, and the relatively few marine mammals that are likely to feed on the bottom in the deeper waters where these would be expended. It is probably 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. An animal would have to swim through loops or become twisted within the cable or wire to become entangled, and given the properties of the expended cables and wires (low breaking strength and sinking rates) this seems unlikely. Furthermore, an animal may initially become entangled in a cable or wire but easily become free, and therefore 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.

3.4.3.4.4.1 No Action Alternative

Training Activities

Refer to Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires) for the approximate number of events and locations where cables and wires would be expended.

The area that will have the greatest concentration of expended fiber optic cables or guidance wires is within the VACAPES Range Complex (specifically W-50). The W-50 location includes 123 nautical square miles (nm^2) of sea space. Under the No Action Alternative, there would be approximately seven cables per nm^2 if they were expended evenly throughout the area. There has never been a reported or recorded incidence of any marine mammal being entangled by guidance wires or fiber optic cables, or by any other military expended material.

Pursuant to the MMPA, the use of fiber optic cables and guidance wires during training activities as described in the No Action Alternative is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Refer to Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires) for the approximate number of events and locations where cables and wires would be expended.

Cables and wires would be expended with greatest concentration in the Gulf of Mexico Large Marine Ecosystem (specifically Naval Surface Warfare Center, Panama City Division Testing Range). Under the No Action Alternative, there would be approximately one cable per 17 nm^2 if they were expended evenly throughout area. Based on this low concentration, likelihood of an animal encountering one of these items is extremely low.

Pursuant to the MMPA, the use of fiber optic cables and guidance wires during testing activities as described in the No Action Alternative is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.4.4.2 Alternative 1

Training Activities

Under Alternative 1, fiber optic cables expended during training activities would increase about 240 percent and guidance wires expended would increase about 22 percent above the No Action Alternative. As with the No Action Alternative, they could be expended anywhere within the Study Area but would be expended with greatest concentration in the Northeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area (specifically the VACAPES Range Complex). This would result in a maximum concentration of approximately one cable every 16 nm^2 if they were expended evenly throughout the area. While there is an increase in fiber optic cables and guidance wires that would be expended under Alternative 1, the resulting concentration is lower than for the No Action Alternative because the area where the cables would be expended is larger. Based on this low concentration, likelihood of an animal encountering one of these items is extremely low.

Pursuant to the MMPA, the use of fiber optic cables and guidance wires during training activities as described in Alternative 1 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of fiber optic cables and guidance wires for training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Under Alternative 1, fiber optic cables expended during testing activities would increase by 117 percent and guidance wires expended would increase to about six times the No Action Alternative. As with the No Action Alternative, they could be expended anywhere within the Study Area but would be expended with greatest concentration in the Gulf of Mexico Large Marine Ecosystem (specifically, Naval Surface Warfare Center, Panama City Division Testing Range). This would result in a maximum concentration of approximately one cable per 7 nm^2 if they were expended evenly throughout the area. While there is an increase in fiber optic cables and guidance wires that would be expended under Alternative 1, the resulting concentration is lower than for the No Action Alternative because the area where the cables would be expended is larger. Based on this low concentration, likelihood of an animal encountering one of these items is extremely low.

Pursuant to the MMPA, the use of fiber optic cables and guidance wires during testing activities as described in Alternative 1 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.4.4.3 Alternative 2 (Preferred Alternative)

Training Activities

Under Alternative 2, fiber optic cables expended during training activities would increase about 240 percent and guidance wires expended would increase about 22 percent above the No Action Alternative. As with the No Action Alternative, they could be expended anywhere within the Study Area but would be expended with greatest concentration in the Northeast U.S. Continental Shelf Large

Marine Ecosystem and Gulf Stream Open Ocean Area (specifically the VACAPES Range Complex). This would result in a maximum concentration of approximately one cable every 16 nm^2 if they were expended evenly throughout the area. While there is an increase in fiber optic cables and guidance wires that would be expended under Alternative 2, the resulting concentration is lower than for the No Action Alternative because the area where the cables would be expended is larger. Based on this low concentration, likelihood of an animal encountering one of these items is extremely low.

Pursuant to the MMPA, the use of fiber optic cables and guidance wires during training activities as described in Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Under Alternative 2, fiber optic cables expended during testing activities would increase approximately 155 percent and guidance wires expended would increase to about 6 times the No Action Alternative. As with the No Action Alternative, they could be expended anywhere within the Study Area but would be expended with greatest concentration in the Northeast U.S. Continental Shelf Large Marine Ecosystem (specifically, Naval Undersea Warfare Center Division, Newport Testing Range). This would result in a maximum concentration of approximately one cable per 7 nm^2 if they were expended randomly in this area. While there is an increase in cables and wires that would be expended under Alternative 2, the resulting concentration is lower than for the No Action Alternative because the area where the cables would be expended is larger. Based on this low concentration, likelihood of an animal encountering one of these items is extremely low.

Pursuant to the MMPA, the use of fiber optic cables and guidance wires during testing activities as described in Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.4.5 Impacts from Parachutes

Refer to Section 3.0.5.3.4.2 (Parachutes) and Table 3.0-72 for the number of training and testing events that involve the use of parachutes and the geographic areas where they would be expended. Training and testing activities that introduce parachutes into the water column can occur anywhere in the Study Area. However, there would be higher use within the range complexes and testing ranges. This section does not analyze impacts to critical habitat, because Section 3.4.3.3.3 (Impacts from Military Expended Materials) already analyzed the potential impacts of parachutes on designated critical habitat.

Entanglement of a marine mammal in a parachute assembly at the surface or within the water column would be unlikely, since the parachute would have to land directly on an animal, or an animal would have to swim into it before it sinks. Once on the seafloor, if bottom currents are present, the canopy may temporarily billow and pose an entanglement threat to marine animals with bottom-feeding habits; however, the probability of a marine mammal encountering a parachute assembly on the seafloor and accidental entanglement in the canopy or suspension lines is unlikely.

The chance that an individual animal would encounter expended parachutes is low based on the distribution of the parachutes expended, the fact that parachute assemblies are designed to sink upon release, and the relatively few animals that feed on the bottom. If a marine mammal did become entangled in a parachute, it could easily become free of the parachute because the parachutes are made of very lightweight fabric. Based on the information summarized within the introduction to Section 3.4.3.4 (Entanglement Stressors), mysticetes found within the Study Area are not expected to encounter parachutes on the seafloor because, with a few exceptions, they do not feed there. Species occurring outside of the range complexes, including the bowhead whale, narwhal, beluga whale, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear would not be expected to encounter parachutes, eliminating the possibility of entanglement.

The possibility of odontocetes, pinnipeds, and manatees becoming entangled exists when they are feeding on the bottom in areas where parachutes have been expended. This is unlikely because parachutes are used in events that generally occur in deeper waters, where these species are not likely to be feeding on the bottom (except sperm whales), though even if momentarily entangled, a marine mammal would likely be able to free itself of the light-weight fabric of a parachute. There has never been any recorded or reported instance of a marine mammal becoming entangled in a parachute.

3.4.3.4.5.1 No Action Alternative

Training Activities

Parachutes could be expended anywhere in the Study Area. However, there would be higher use within the range complexes. Section 3.0.5.3.4.2 (Parachutes) shows the approximate number of events and locations where parachutes would be expended under each alternative.

To estimate a worst-case scenario, calculations were made for the area where parachutes would be expended with greatest concentration. For training events, this is in the Southeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area (specifically, the JAX Range Complex). Under the No Action Alternative, there would be a concentration of approximately one parachute per 2 nm^2 if they were evenly expended throughout the area.

Pursuant to the MMPA, the use of parachutes during training activities as described under the No Action Alternative is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of parachutes during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Parachutes could be expended anywhere in the Study Area. However, there would be higher use within the testing ranges and range complexes. Section 3.0.5.3.4.2 (Parachutes) shows the approximate number of events and locations where parachutes would be expended under each alternative.

To estimate a worst-case scenario, calculations were made for the area where parachutes would be expended with greatest concentration. For testing events, this is in Northeast U.S. Continental Shelf Large Marine Ecosystem and the Gulf Stream Open Ocean Area (specifically, in the VACAPES Range Complex). Under the No Action Alternative, there would be a concentration of approximately one parachute per 22 nm^2 if the parachutes were expended evenly throughout the area.

Pursuant to the MMPA, the use of parachutes during testing activities as described under the No Action Alternative is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of parachutes during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.4.5.2 Alternative 1

Training Activities

Under Alternative 1 for training activities, parachutes use would increase by 5 percent above the No Action Alternative. Section 3.0.5.3.4.2 (Parachutes) shows the approximate number of events and locations where parachutes would be expended under each alternative. As with the No Action Alternative, parachutes could be expended anywhere in the Study Area. However, there would be higher use within the range complexes. Less than 2 percent of the parachutes would be expended outside of range complexes.

To estimate a worst-case scenario, calculations were made for the area where parachutes would be expended with greatest concentration. For training events under Alternative 1, parachutes would be expended with greatest concentration in the Southeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area (specifically, the JAX Range Complex). Under Alternative 1, there would be a concentration of approximately one parachute per 2 nm^2 if the parachutes were expended evenly throughout the area.

Pursuant to the MMPA, the use of parachutes during training activities as described under Alternative 1 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of parachutes during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Under Alternative 1 for testing activities, parachutes use would increase from the No Action Alternative by approximately 3.2 times. These could be expended anywhere in the expanded Study Area, as described in Chapter 2 (Description of Proposed Action and Alternatives), though they will continue to be expended in greater concentrations within the testing ranges and range complexes. Refer to Section 3.0.5.3.4.2 (Parachutes) for the approximate number of events and locations where parachutes would be expended under each alternative. Less than 2 percent of the parachutes would be expended outside of range complexes.

To estimate a worst-case scenario, calculations were made for the area where parachutes would be expended with greatest concentration. For testing events, this is in Northeast U.S. Continental Shelf Large Marine Ecosystem and the Gulf Stream Open Ocean Area (specifically, in the VACAPES Range Complex). Under Alternative 1, there would be a concentration of approximately one parachute per 5 nm^2 if the parachutes were expended evenly throughout the area.

Pursuant to the MMPA, the use of parachutes during testing activities as described under Alternative 1 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of parachutes during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.4.5.3 Alternative 2 (Preferred Alternative)

Training Activities

Under Alternative 2 for training activities, parachutes use would increase by 5 percent above the No Action Alternative. However, less than 2 percent of the parachutes would be expended outside of range complexes. These could be expended anywhere in the expanded Study Area, as described in Chapter 2 (Description of Proposed Action and Alternatives), though they will continue to be expended in greater concentrations within the range complexes. Section 3.0.5.3.4.2 (Parachutes) shows the approximate number of events and locations where parachutes would be expended under each alternative. To estimate a worst-case scenario, calculations were made for the area where parachutes would be expended with greatest concentration. For training events under Alternative 2, parachutes would be expended with greatest concentration in the Southeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area (specifically, the JAX Range Complex). Under Alternative 2, there would be a concentration of approximately one parachute per 2 nm^2 if the parachutes were expended randomly throughout the area.

Pursuant to the MMPA, the use of parachutes during training activities as described under Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of parachutes during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Under Alternative 2, parachutes use would increase from the No Action Alternative by 4 times. These could be expended anywhere in the expanded Study Area, as described in Chapter 2 (Description of Proposed Action and Alternatives), though they will continue to be expended in greater concentrations within the testing ranges and range complexes. Section 3.0.5.3.4.2 (Parachutes) shows the approximate number of events and locations where parachutes would be expended under each alternative. Less than 3 percent of the parachutes would be expended outside of range complexes.

To estimate a worst-case scenario, calculations were made for the area where parachutes would be expended with greatest concentration. For testing events, this is in the Northeast U.S. Continental Shelf Large Marine Ecosystem and the Gulf Stream Open Ocean Area (specifically, in the VACAPES Range Complex). Under Alternative 2, there would be a concentration of approximately one parachute per 4 nm^2 if the parachutes were expended evenly throughout the area.

Pursuant to the MMPA, the use of parachutes during testing activities as described under Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, the use of parachutes during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.5 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 two categories of military expended materials: (1) munitions (both non-explosive practice munitions and fragments from high-explosive munitions), and (2) materials other than munitions, including fragments from targets, chaff, flares, and parachutes. Section 3.0.5.3.5 (Ingestion Stressors) discusses the types of activities that use these materials, where they are used, and how many events will occur under each alternative. This section does not analyze impacts on critical habitat because Section 3.4.3.3.3 (Impacts from Military Expended Materials) already analyzed the potential impacts of expended materials on designated critical habitat.

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.

3.4.3.5.1 Mysticetes

Blue, fin, North Atlantic right, and sei whales feed at the surface or in the water column. While humpback whales feed predominantly by lunging through the water after krill and fish, there are instances of humpback whales disturbing the bottom in an attempt to flush prey, the northern sand lance (*Ammodytes dubius*) (Hain et al. 1995). Although observations of humpback whales feeding in mid-Atlantic waters (Smith et al. 1996; Swingle et al. 1993) have led to the supposition that a supplemental winter feeding ground may exist in the U.S. mid-Atlantic (Barco et al. 2002), humpback whale feeding primarily takes place farther north than the VACAPES Range Complex (Cetacean and Turtle Assessment Program 1982; Kenney and Winn 1986; Weinrich et al. 1997; Whitehead 1982). In a comprehensive review of documented ingestion of debris by marine mammals, there are two species of mysticetes (bowhead and minke whale) with ingestion records (Laist 1997). The items ingested included plastic sheeting and a polythene bag (Laist 1997). Based on the available evidence, it is possible that mysticetes may ingest items found on the surface or within the water column. However, with the exception of the humpback whale, it is not likely that mysticetes would encounter items found on the seafloor.

3.4.3.5.2 Odontocetes

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 and Coe 1990). Recently 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 and 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).

3.4.3.5.3 Pinnipeds

Most of the seal species within the Study Area feed both within the water column and on the seafloor, and walrus feed primarily on benthic invertebrates (Bluhm and Grandinger 2008). In a comprehensive review of documented ingestion of debris by marine mammals, pinnipeds only had two species (northern elephant seal and Steller sea lion) with ingestion records, both were documented as ingesting Styrofoam cups (Laist 1997).

3.4.3.5.4 Polar Bear

Polar bears feed primarily on other marine mammals (especially ringed seals, bearded seals, and harp seals) while on land and ice or out at sea (Bluhm and Grandinger 2008).

3.4.3.5.5 West Indian Manatee

Manatees feed on sea grass beds in relatively shallow coastal or estuarine waters. In a comprehensive review of documented ingestion of debris by marine mammals, the West Indian manatee had ingestion records that included monofilament line, plastic bags, string, twine, rope, fish hooks, wire, paper, cellophane, and rubber bands (Laist 1997).

3.4.3.5.6 Impacts from Munitions

Many 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. This section does not analyze impacts to critical habitat, because Section 3.4.3.3.3 (Impacts from Military Expended Materials) already analyzed the potential impacts of munitions on designated critical habitat.

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. (57 mm) in diameter. These solid metal materials would quickly move through the water column and settle to the sea floor. 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, grenades, 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 3.4.3.5.1 (Mysticetes), mysticetes found within the Study Area, with the exception of bottom-feeding 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. Polar bears feed primarily on other marine mammals and are not likely to encounter non-explosive practice munitions on the sea floor. Although manatees feed on the bottom, their distribution and foraging is limited to shallow coastal and estuarine waters, thus preventing them from encountering non-explosive practice munitions.

3.4.3.5.6.1 No Action Alternative

<u>Training Activities</u>

Non-explosive practice munitions

As discussed in Section 3.0.5.3.5 (Ingestion Stressors), under the No Action Alternative, training activities involving small- and medium-caliber non-explosive practice munitions occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area within the VACAPES, Navy Cherry Point, JAX, GOMEX, and Key West Range Complexes. Small- and medium-caliber non-explosive practice rounds would be expended with greatest concentration within the VACAPES Range Complex. Species not occurring in these areas, including the bowhead whale, narwhal, beluga whale, white-beaked dolphin, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear, would not encounter small- and medium-caliber non-explosive practice munitions.

Marine mammal species occurring within the range complexes listed above, which are within the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, as well as portions of the Gulf Stream Open Ocean Area, need to be evaluated based on their feeding habits and potential to encounter projectiles. Mysticete species that occur where these training activities take place are not expected to encounter small- or medium-caliber projectiles because they feed near the surface or within the water column. Although manatees may occur in these areas, these training activities would not take place in shallow coastal and estuarine waters where manatees feed. Odontocete and pinniped species that occur in these areas, some of which forage on the bottom, could potentially ingest small- or medium-caliber projectiles if encountered.

The amount of small- and medium-caliber projectiles 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. 2008a). Therefore, potential impacts of non-explosive practice munitions ingestion would be limited to the unlikely event where 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.

Fragments from high-explosive munitions

As discussed in Section 3.0.5.3.5 (Ingestion Stressors), under the No Action Alternative, training activities involving high-explosive munitions including bombs, medium- and large-caliber projectiles, missiles, and rockets would be used in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area within the VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. High-explosive munition use would be most concentrated in the VACAPES and JAX Range Complexes. Species not occurring in these areas, including the bowhead whale, narwhal, beluga whale, white-beaked dolphin, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear would not encounter fragments from high-explosive munitions.

Marine mammal species occurring within the range complexes listed above need to be evaluated based on their feeding habits and potential to encounter projectiles. Mysticete species that occur where these training activities take place are not expected to encounter high-explosive munitions fragments because they feed near the surface or within the water column. Although manatees may occur in these areas, these training activities would not take place in shallow coastal and estuarine waters where manatees feed. Odontocete and pinniped species, which occur in these areas, some of which forage on the bottom, could potentially ingest high-explosive munitions fragments if encountered.

The amount of high-explosive munitions fragments that an individual animal would encounter is generally low based on the patchy distribution of both the munitions and an animal's feeding habitat. In addition, an animal would not likely ingest every fragment it encountered. Furthermore, an animal may attempt to ingest a fragment 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. 2008a). Therefore, potential impacts of high-explosive munitions fragment ingestion would be limited to the unlikely event where 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.

Pursuant to the MMPA, ingestion of munitions used during training activities as described under the No Action Alternative is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, ingestion of munitions used during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

<u>Testing Activities</u>

Non-explosive practice munitions

As discussed in Section 3.0.5.3.5 (Ingestion Stressors), under the No Action Alternative, testing activities involving small- and medium-caliber non-explosive practice munitions occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area, within Naval Surface Warfare Center, Panama City Division Testing Range and the VACAPES, JAX, and Key West Range Complexes, the Gulf of Mexico, and in other areas outside of the range complexes. Small- and medium-caliber non-explosive practice rounds would be expended with greatest concentration within the Naval Surface Warfare Center, Panama City Division Testing Range. Species not occurring in these areas, including the bowhead whale, narwhal, beluga whale, white-beaked dolphin, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear would not encounter small- and medium-caliber non-explosive practice munitions.

Marine mammal species that occur within the range complexes listed above need to be evaluated based on their feeding habits and potential to encounter projectiles. Mysticete species that occur where these testing activities take place are not expected to encounter small- or medium-caliber projectiles because they feed near the surface or within the water column. Although manatees may occur in these areas, these testing activities would not take place in shallow coastal and estuarine waters where manatees feed. Odontocete and pinniped species, which occur in these areas, some of which forage on the bottom, could potentially ingest small- or medium-caliber projectiles if encountered.

The amount of small- and medium-caliber projectiles 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. 2008a). Therefore, potential impacts of non-explosive practice munitions ingestion would be limited to the unlikely event where 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.

Fragments from high-explosive munitions

As discussed in Section 3.0.5.3.5 (Ingestion Stressors), under the No Action Alternative, testing activities involving high-explosive munitions, including bombs, medium- and large-caliber projectiles, missiles, and rockets, would be used in the Northeast U.S. Continental Shelf and Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area and Naval Surface Warfare Center, Panama City Division Testing Range. Species not occurring in these areas, including the bowhead whale, narwhal, beluga whale, white-beaked dolphin, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear would not encounter fragments from high-explosive munitions.

Marine mammal species occurring within the areas listed above need to be evaluated based on their feeding habits and potential to encounter projectiles. Mysticete species that occur where these testing activities take place are not expected to encounter high-explosive munitions fragments because they feed near the surface or within the water column. Although manatees may occur in these areas, these testing activities would not take place in shallow coastal and estuarine waters where manatees feed. Odontocete and pinniped species, which occur in these areas, some of which forage on the bottom, could potentially ingest high-explosive munitions fragments if encountered.

The amount of high-explosive munitions fragments that an individual animal would encounter is generally low based on the patchy distribution of both the munitions and an animal's feeding habits. In addition, an animal would not likely ingest every fragment it encountered. Furthermore, an animal may attempt to ingest a fragment 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. 2008a). Therefore, potential impacts of high-explosive munitions fragment ingestion would be limited to the unlikely event where 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.

Pursuant to the MMPA, ingestion of munitions used during testing activities as described under the No Action Alternative is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, ingestion of munitions used during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.5.6.2 Alternative 1

Training Activities

Non-explosive practice munitions

Under Alternative 1, small- and medium-caliber non-explosive practice munitions use would increase by approximately 220 percent as compared to the No Action Alternative, and a small portion of these activities may also occur outside the range complexes within the remainder of the Study Area.

As discussed in Section 3.0.5.3.5 (Ingestion Stressors), under Alternative 1, training activities involving small- and medium-caliber non-explosive practice munitions occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, as well as the Gulf

Stream Open Ocean Area within the Northeast, VACAPES, Navy Cherry Point, JAX, GOMEX, and Key West Range Complexes, as well as other areas outside of the range complexes. Small- and medium-caliber non-explosive practice rounds would be expended with greatest concentration within the VACAPES Range Complex. Marine mammal species that occur within the range complexes listed above need to be evaluated based on their feeding habits and potential to encounter projectiles. Mysticete species that occur where these training activities take place are not expected to encounter small- or medium-caliber projectiles because they feed near the surface or within the water column. Although manatees may occur in these areas, these training activities would not take place in shallow coastal and estuarine waters where manatees would be feeding. Odontocete and pinniped species, which occur in these areas and forage on the bottom, could potentially ingest small- or medium-caliber projectiles if encountered.

The amount of small- and medium-caliber projectiles 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. 2008a). Therefore, potential impacts of non-explosive practice munitions 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.

Fragments from high-explosive munitions

Under Alternative 1, training activities involving high-explosive munitions, including bombs, medium- and large-caliber projectiles, missiles, and rockets, would increase substantially compared to the No Action Alternative. The majority of this increase is due to the inclusion of high-explosive, medium-caliber projectiles that were accounted for as non-explosive practice munitions under the No Action Alternative. In addition, a small portion of these activities may occur outside the range complexes within the remainder of the Study Area.

Section 3.0.5.3.5 (Ingestion Stressors) provides the number and location of activities that expend fragments from high-explosive munitions. Activities would occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area within the Northeast, VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes. Use of high-explosive munitions would be most concentrated in the VACAPES and JAX Range Complexes.

Marine mammal species occurring within the range complexes listed above need to be evaluated based on their feeding habits and potential to encounter projectiles. Mysticete species that occur where these training activities take place are not expected to encounter high-explosive munitions fragments because they feed near the surface or within the water column. Although manatees may occur in these areas, these training activities would not take place in shallow coastal and estuarine waters where manatees feed. Odontocete and pinniped species, which occur in these areas, some of which forage on the bottom, could potentially ingest high-explosive munitions fragments if encountered.

The amount of high-explosive munitions fragments that an individual animal would encounter is generally low based on the patchy distribution of both the munitions and an animal's feeding habits. In addition, an animal would not likely ingest every fragment it encountered. Furthermore, an animal may attempt to ingest a fragment 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. 2008a). Therefore, potential impacts of high-explosive munitions fragment 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.

Pursuant to the MMPA, ingestion of munitions used during training activities as described under Alternative 1 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, ingestion of munitions used during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Non-explosive practice munitions

Under Alternative 1, small- and medium-caliber non-explosive practice munitions use would increase by approximately 4.4 times as compared to the No Action Alternative, and a small portion of these activities may occur outside of the range complexes within the remainder of the Study Area.

As discussed in Section 3.0.5.3.5 (Ingestion Stressors), under Alternative 1, testing activities involving small- and medium-caliber non-explosive practice munitions occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area, within Naval Surface Warfare Center, Panama City Division Testing Range and the VACAPES, JAX, and Key West Range Complexes, the Gulf of Mexico, and in other areas outside of the range complexes. Small- and medium-caliber non-explosive practice rounds would be expended with greatest concentration within the Naval Surface Warfare Center, Panama City Division Testing Range.

Marine mammal species that occur within the range complexes listed above need to be evaluated based on their feeding habits and potential to encounter projectiles. Mysticete species that occur where these testing activities take place are not expected to encounter small- or medium-caliber projectiles because they feed near the surface or within the water column. Although manatees may occur in these areas, these testing activities would not take place in shallow coastal and estuarine waters where manatees feed. Odontocete and pinniped species, which occur in these areas, some of which forage on the bottom, could potentially ingest small- or medium-caliber projectiles if encountered.

The amount of small- and medium-caliber projectiles 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. 2008a). Therefore, potential impacts of non-explosive practice munitions 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.

Fragments from high-explosive munitions

Under Alternative 1, testing activities involving high-explosive munitions, including bombs, medium- and large-caliber projectiles, missiles, and rockets, would increase substantially compared to the No-Action-Alternative. The majority of this increase is due to the inclusion of high-explosive, medium-caliber projectiles that were accounted for as non-explosive practice munitions under the No Action Alternative. In addition a small portion of these activities may occur outside the range complexes within the remainder of the Study Area.

Section 3.0.5.3.5 (Ingestion Stressors) provides the number and location of activities that expend fragments from high-explosive munitions. Activities would occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area within the Naval Surface Warfare Center, Panama City Division Testing Range, Northeast, VACAPES, JAX, and Key West Range Complexes, Gulf of Mexico, and other locations outside of the range complexes.

Marine mammal species occurring within the range complexes listed above need to be evaluated based on their feeding habits and potential to encounter projectiles. Mysticete species that occur where these training activities take place are not expected to encounter high-explosive munitions fragments because they feed near the surface or within the water column. Although manatees may occur in these areas, these training activities would not take place in shallow coastal and estuarine waters where manatees feed. Odontocete and pinniped species, which occur in these areas, some of which forage on the bottom, could potentially ingest high-explosive munitions fragments if encountered.

The amount of high-explosive munitions fragments that an individual animal would encounter is generally low based on the patchy distribution of both the munitions and an animal's feeding habits. In addition, an animal would not likely ingest every fragment it encountered. Furthermore, an animal may attempt to ingest a fragment 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. 2008a). Therefore, potential impacts of high-explosive munitions fragment 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.

Pursuant to the MMPA, ingestion of munitions used during testing activities as described under Alternative 1 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, ingestion of munitions used during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.5.6.3 Alternative 2 (Preferred Alternative)

Training Activities

Training activities under Alternative 2 are identical to those described in Section 3.4.3.5.6.2 (Alternative 1), Training Activities.

Pursuant to the MMPA, ingestion of munitions used during training activities as described under Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, ingestion of munitions used during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Testing activities under Alternative 2 are similar those described in Section 3.4.3.5.6.2 (Alternative 1), Testing Activities, with only a 10 percent difference in the number of small- and medium-caliber non-explosive practice munitions and high-explosive munitions being used.

Pursuant to the MMPA, ingestion of munitions used during testing activities as described under Alternative 2 is *not expected to result in mortality or Level A or Level B harassment of marine mammals.*

Pursuant to the ESA, ingestion of munitions used during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.5.7 Impacts from Military Expended Materials Other than Munitions

Several different types of materials other than munitions are expended at sea during training and testing activities. The following military expended materials other than munitions have the potential to be ingested by marine mammals:

- Target-related materials
- Chaff (including fibers, end caps, and pistons)
- Flares (including end caps and pistons)
- Parachutes (cloth, nylon, and metal weights)

This section does not analyze impacts to critical habitat, because Section 3.4.3.3.3 (Impacts from Military Expended Materials) already analyzed the potential impacts of these military expended materials on designated critical habitat.

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.

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 of chaff drifting 200 mi. (322 km) from the point of release, with the plume covering greater than 400 cubic miles ($mi.^3$) (1,667 cubic kilometers [km^3]) (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; Hullar et al. 1999; U.S. Air Force 1997). 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. 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), Hullar et al. (1999), and 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 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 (Hullar et al. 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. Air Force 1997).

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 marine mammals. Chaff end caps and pistons sink in saltwater (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 end cap and piston (approximately 1.4 in. [3.6 cm] in diameter).

An extensive literature review and controlled experiments conducted by the U.S. Air Force demonstrated that self-protection flare use poses little risk to the environment or animals (U.S. Air Force 1997). Nonetheless, marine mammals within the vicinity of flares could be exposed to light generated by the flares. Pistons and end caps 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.

Parachutes

Aircraft-launched sonobuoys, lightweight torpedoes (such as the MK 46 and MK 54), and targets use nylon parachutes ranging in size from 18 to 48 in. (46 to 122 cm) in diameter. Parachutes are made up of cloth and nylon, with weights attached to the lines for rapid sinking upon impact with the water. At water impact, the parachute assembly is expended, and it sinks away from the unit. The parachute assembly may remain at the surface for a short time before it and its housing sink to the seafloor, where it becomes flattened (Environmental Sciences Group 2005). Some parachutes are weighted with metal clips to hasten their descent to the seafloor.

Ingestion of a parachute by a marine mammal at the surface or within the water column would be unlikely, since the 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 3.4.3.5.1 (Mysticetes), mysticetes found within the Study Area, with the exception of bottom-feeding humpback whales are not expected to encounter parachutes on the seafloor because they do not feed there. Polar bears feed primarily on other marine mammals and are not likely to encounter parachutes on the sea floor. Ingestion of parachutes by odontocetes and pinnipeds is unlikely but is possible if individuals are feeding on the bottom. Although manatees may occur in these areas, these activities would not take place in shallow coastal and estuarine waters where manatees feed.

3.4.3.5.7.1 No Action Alternative

Training Activities

Section 3.0.5.3.5 (Ingestion Stressors), lists the number and locations of activities that expend parachutes, target materials, chaff, and flares. Under the No Action Alternative, training activities involving military expended materials other than munitions take place in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area within the Northeast, VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes. Target-related material, chaff, flares, parachutes, and their subcomponents have the potential to be ingested by a marine mammal, although 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. Species not occurring in these areas, including the bowhead whale, narwhal, beluga whale, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear would not encounter these items.

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
- Limited period of time these military expended materials would remain in the water column
- Unlikely chance that a marine mammal might encounter and swallow these items on the seafloor
- The ability of many marine mammals to reject and not swallow nonfood items incidentally ingested

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 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.

Pursuant to the MMPA, ingestion of military expended materials other than munitions used during training activities as described under the No Action Alternative is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, ingestion of military expended materials other than munitions used during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Section 3.0.5.3.5 (Ingestion Stressors) provides the number and locations of activities that expend parachutes, target materials, chaff, and flares. Under the No Action Alternative, testing activities involving military expended materials other than munitions take place in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area within the Northeast, Navy Cherry Point, VACAPES, and JAX Range Complexes, and the Naval Surface Warfare Center, Panama City Division Testing Range. Target-related material, chaff, flares, parachutes, and their subcomponents have the potential to be ingested by a marine mammal, although 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. Species not occurring in these areas, including the bowhead whale, narwhal, beluga whale, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear, would not encounter these items.

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
- Limited period of time these military expended materials would remain in the water column
- Unlikely chance that a marine mammal might encounter and swallow these items on the seafloor
- The ability of many marine mammals to reject and not swallow nonfood items incidentally ingested

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 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.

Pursuant to the MMPA, ingestion of military expended materials other than munitions used during testing activities as described in the No Action Alternative is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, ingestion of military expended materials other than munitions used during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.5.7.2 Alternative 1

Training Activities

Under Alternative 1, training activities involving military expended materials other than munitions will increase or decrease as follows – 10 percent increase in parachutes, 35 percent decrease in chaff, 25 percent increase in flares, and 77 percent increase in airborne, surface, and sub-surface targets. Activities will take place in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area within the Northeast, VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes. Target-related material, chaff, flares, parachutes, and their subcomponents have the potential to be ingested by a marine mammal, although 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. Species not occurring in these areas, including the bowhead whale, narwhal, beluga whale, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear, would not encounter these items.

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
- Limited period of time these military expended materials would remain in the water column
- Unlikely chance that a marine mammal might encounter and swallow these items on the seafloor
- The ability of many marine mammals to reject and not swallow nonfood items incidentally ingested

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 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. Nonmunition 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.

Pursuant to the MMPA, ingestion of military expended materials other than munitions used during training activities as described under Alternative 1 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, ingestion of military expended materials other than munitions used during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Under Alternative 1, testing activities involving military expended materials other than munitions will increase as follows – a four-fold increase in parachutes, a two-fold increase in chaff, a 110 percent increase in flares, and a two-fold increase in airborne, surface, and sub-surface targets. Activities will take place in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area within the Northeast, VACAPES, Navy Cherry Point, Key West, and JAX Range Complexes, Gulf of Mexico, and Naval Surface Warfare Center, Panama City Division Testing Range. Target-related material, chaff, flares, parachutes, and their subcomponents have the potential to be ingested by a marine mammal, although 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. Species not occurring in these areas, including the bowhead whale, narwhal, beluga whale, long-beaked common dolphin, ringed seal, bearded seal, harp seal, walrus, and polar bear would not encounter these items.

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
- Limited period of time these military expended materials would remain in the water column
- Unlikely chance that a marine mammal might encounter and swallow these items on the seafloor
- The ability of many marine mammals to reject and not swallow nonfood items incidentally ingested

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 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.

Pursuant to the MMPA, ingestion of military expended materials other than munitions used during testing activities as described under Alternative 1 is *not expected to result in mortality or Level A or Level B harassment of marine mammals.*

Pursuant to the ESA, ingestion of military expended materials other than munitions used during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.5.7.3 Alternative 2 (Preferred Alternative)

Training Activities

Training activities under Alternative 2 are identical to those training activities described in Section 3.4.3.5.7.2 (Alternative 1).

Pursuant to the MMPA, ingestion of military expended materials other than munitions used during training activities as described under Alternative 2 is *not expected to result in mortality or Level A or Level B harassment of marine mammals.*

Pursuant to the ESA, ingestion of military expended materials other than munitions used during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

Testing Activities

Under Alternative 2, testing activities involving military expended materials other than munitions will increase as follows – a five-fold increase in parachutes, a two-fold increase in chaff, a 130 percent increase in flares, and a two and a half-fold increase in airborne, surface, and sub-surface targets.

Pursuant to the MMPA, ingestion of military expended materials other than munitions used during testing activities as described under Alternative 2 is not expected to result in mortality or Level A or Level B harassment of marine mammals.

Pursuant to the ESA, ingestion of military expended materials other than munitions used during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, West Indian manatee, ringed seal, and polar bear.*

3.4.3.6 Secondary Stressors

This section analyzes potential impacts on marine mammals exposed to stressors indirectly through impacts on their habitat (i.e., sediment or water quality) or prey. For the purposes of this analysis, indirect impacts on marine mammals via sediment or water that do not require trophic transfer (e.g., bioaccumulation) in order to be observed are considered here. 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. Bioaccumulation is considered in the *Ecosystem Technical Report for the Atlantic Fleet Training and Testing (AFTT) Draft Environmental Impact Statement* (U.S. Department of the Navy 2012b).

Stressors from Navy training and testing activities could pose indirect impacts on marine mammals via habitat or prey. These include: (1) explosives and byproducts, (2) metals, (3) chemicals, and (4) transmission of disease and parasites. Analyses of the potential impacts on sediment and water quality are discussed in Section 3.1 (Sediments and Water Quality).

3.4.3.6.1 Explosives

In addition to directly impacting 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 on the type of prey species in the area of the blast.

In addition to physical effects of an underwater blast, prey might have behavioral reactions to underwater sound. 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 and Messenger 1996). The abundances of prey species near the detonation point could be diminished for a short period 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. 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.

3.4.3.6.2 Explosion Byproducts and Unexploded Ordnance

High-order explosions consume most of the explosive material, creating typical combustion products. In the case of royal demolition explosive, 98 percent of the products are common seawater constituents, and the remainder is rapidly diluted below threshold effect level (Section 3.1, Sediments and Water Quality, Table 3.1-13 and Table 3.1-14). Explosion byproducts associated with high-order detonations present no indirect stressors to marine mammals through sediment or water. However, low-order detonations and unexploded ordnance 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 (Section 3.1, Sediments and Water Quality, Table 3.1-10). Marine mammals may be exposed by contact with the explosive, contact with contaminants in the sediment or water, and ingestion of contaminated sediments.

Indirect impacts of explosives and unexploded ordnance to marine mammals via sediment is possible in the immediate vicinity of the ordnance. Degradation of explosives proceeds through several pathways, as discussed in Section 3.1.3.1 (Explosives and Explosion Byproducts). Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen and 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 to 12 in. (0.15 to 0.3 m) away from degrading ordnance, the concentrations of these compounds were not statistically distinguishable from background beyond 3 to 6 ft. (1 to 2 m) from the degrading ordnance (Section 3.1.3.1, Explosives and Explosion 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. [0.3 to 2 m]).

3.4.3.6.3 Metals

Metals are introduced into seawater and sediments as a result of training and testing activities involving ship hulks, targets, ordnance, munitions, and other military expended materials (Section 3.1.3.2, Metals). Some metals bioaccumulate and physiological impacts begin to occur only after several trophic transfers concentrate the toxic metals (Chapter 4.0, Cumulative Impacts). Indirect impacts of metals to marine mammals via sediment and water involve concentrations several orders of magnitude lower than concentrations achieved via bioaccumulation. Marine mammals may be exposed by contact with the metal, contact with contaminants in the sediment or water, and ingestion of contaminated sediments. Concentrations of metals in sea water are orders of magnitude lower than concentrations in marine sediments. It is extremely unlikely that marine mammals would be indirectly impacted by metals via the water, and few marine mammal species feed primarily on the seafloor, where they would come into contact with marine sediments.

3.4.3.6.4 Chemicals

Several Navy training and testing activities introduce potentially harmful chemicals into the marine environment, principally, flares and propellants for rockets, missiles, and torpedoes. Properly functioning flares, missiles, rockets, and torpedoes combust most of their propellants, leaving benign or readily diluted soluble combustion byproducts (e.g., hydrogen cyanide). Operational failures allow propellants and their degradation products to be released into the marine environment. The greatest risk to marine mammals from flares, missile, and rocket propellants that operationally fail is perchlorate, which is highly soluble in water, persistent, and impacts metabolic processes in many plants and animals. Marine mammals may be exposed by contact with contaminated water. However, rapid dilution would occur, and toxic concentrations are unlikely to be encountered in seawater.

3.4.3.6.5 Transmission of Marine Mammal Diseases and Parasites

The U.S. Navy deploys trained Atlantic bottlenose dolphins (*Tursiops truncatus*) and California sea lions (*Zalophus californianus*) 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 one to two 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. 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 civilian port defense activities.

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 [SECNAVINST] 3900.41E). Appendix A, Section 8, of the Swimmer Interdiction Security System Final EIS (U.S. Department of the Navy 2009b) 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:

1. Qualified veterinarians conduct routine and predeployment health examinations on the Navy's marine mammals; only animals determined as healthy are allowed to deploy.
2. Restaurant-quality frozen fish are fed to prevent diseases that can be caused by ingesting fresh fish (e.g., parasitic diseases).
3. Navy animals are routinely dewormed to prevent parasitic and protozoal diseases.
4. 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:

1. Marine mammal waste is disposed of in an approved system dependent upon the animal's specific housing enclosure and location.

2. 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.
3. Marine mammal handlers visually scan for indigenous marine animals for at least five 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.
4. The Navy obtains appropriate state agriculture and other necessary permits and strictly adheres to the conditions of the permit.

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.

3.4.3.6.6 No Action Alternative, Alternative 1, and Alternative 2 – Training

Pursuant to the MMPA, secondary stressors resulting from training activities as described under the No Action Alternative, Alternative 1, and Alternative 2 are not expected to result in mortality, Level A or Level B harassment of marine mammals.

Pursuant to the ESA, secondary stressors resulting from training activities as described under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect but are not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, West Indian manatee, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.3.6.7 No Action Alternative, Alternative 1, and Alternative 2 – Testing

Pursuant to the MMPA, secondary stressors resulting from testing activities as described under the No Action Alternative, Alternative 1, and Alternative 2 are not expected to result in mortality, Level A or Level B harassment of marine mammals.

Pursuant to the ESA, secondary stressors resulting from testing activities as described under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect but are not likely to adversely affect the ESA-listed North Atlantic right whale, humpback whale, sei whale, fin whale, blue whale, West Indian manatee, and sperm whale;*
- *will have no effect on the ESA-listed bowhead whale, ringed seal, and polar bear; and*
- *will have no effect on North Atlantic right whale and West Indian manatee critical habitats.*

3.4.4 SUMMARY OF IMPACTS ON MARINE MAMMALS

3.4.4.1 Combined Impact of All Stressors

As described in Section 3.0.5.5 (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 the analyses of each stressor in the sections above and summarized in Sections 3.4.4.2 (Endangered Species Act Determinations) and 3.4.4.3 (Marine Mammal Protection Act Determinations).

There are generally two ways that a marine mammal could be exposed to multiple stressors. The first would be if a marine mammal 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 as described in the Proposed Action involve multiple 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. This would be even more likely to occur during large-scale exercises or events that span days or weeks (such as a sinking exercise or composite training unit exercise).

Secondly, a marine mammal could be exposed to a combination of stressors from multiple activities over the course of its life. This is most likely to occur in areas where testing and training activities are more concentrated (e.g., near ports, piers, testing ranges, and routine event locations) and an individual marine mammal frequents the area because it is within the animal's home range, migratory corridor, calving or feeding area. Except for the few concentration areas discussed above, combinations are unlikely to occur because training and testing activities are generally separated in space and time so that it would be very unlikely that any individual marine mammal would be exposed to stressors from multiple activities. 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. The majority of the proposed activities are unit level. Unit level events occur over a small spatial scale (1 to a few square miles) and with few participants (usually one or two) or short duration (the order of a few hours or less). Time is a factor with respect to the probability of exposure. Because most Navy stressors persist for a time shorter than or equal to the duration of the activity, the odds of exposure to combined stressors is lower than would be the case for persistent stressors. For example, strike stressors cease with the passage of the object; ingestion stressors cease (mostly) when the object settles to the seafloor. The animal would have to be present during each of the brief windows that the stressors exist.

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. Navy research and monitoring efforts include 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.

Although potential impacts on certain marine mammal species from the Proposed Action may include injury or mortality, impacts are not expected to decrease the overall fitness of any given population. In cases where potential impacts rise to the level that warrants mitigation, mitigation measures designed to reduce the potential impacts are discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). The potential impacts anticipated from the Proposed Action are summarized in Sections 3.4.4.2 (Endangered Species Act Determinations) through 3.4.4.3 (Marine Mammal Protection Act Determinations) for each regulation applicable to marine mammals.

3.4.4.2 Endangered Species Act Determinations

The U.S. Fish and Wildlife Service and NMFS jointly administer the ESA. The guidelines followed to make a determination of no effect; may affect not likely to adversely affect; or may affect likely to adversely affect can be found in the *ESA Consultation Handbook* (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998).

Table 3.4-37 provides the determinations made for each substressor and ESA-listed marine mammal species from the analysis presented in the sections previously. Pursuant to the ESA, the Navy has undertaken Section 7 consultation with NMFS and U.S. Fish and Wildlife Service for the proposed and ongoing activities in the AFTT Study Area under Alternative 2 (Preferred Alternative). For all substressors, training and testing activities will have no effect on North Atlantic right whale or West Indian manatee critical habitat. The U.S. Fish and Wildlife Service consultation is complete and the Service concurred with the Navy’s determinations.

3.4.4.3 Marine Mammal Protection Act Determinations

Pursuant to the MMPA, the Navy is seeking two Letters of Authorization from NMFS for certain training and testing activities (the use of sonar and other active acoustic sources, explosives, pile driving, and vessels), as described under the Preferred Alternative (Alternative 2). The use of sonar, other active sources, and explosives may result in Level A harassment, Level B harassment, or mortality of certain marine mammals; pile driving may result in Level A or Level B harassment of bottlenose dolphins. The use of vessels may result in mortality or Level A harassment of certain marine mammal species. Refer to Section 3.4.3.1.8 (Impacts from Sonar and Other Active Acoustic Sources) for details on the estimated impacts from acoustic sources (sonar and other active acoustic sources), Section 3.4.3.1.9 (Impacts from Explosives) for impacts from explosives, Section 3.4.3.1.10 (Impacts from Pile Driving) for impacts from pile driving, and Section 3.4.3.3.1 (Impacts from Vessels) for details on the estimated impacts from vessels.

Navy training and testing activities involving swimmer defense airguns, weapons firing, launch, and impact noise, vessel noise, aircraft noise, energy sources, in-water devices, expending military materials, and secondary stressors are not expected to result in Level A or Level B harassment of any marine mammals.

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Table 3.4-37: Endangered Species Act Determinations for Training and Testing Activities for the Preferred Alternative (Alternative 2)

Stressor		North Atlantic Right Whale	Bowhead Whale	Humpback Whale	Sei Whale	Fin Whale	Blue Whale	Sperm Whale	Polar Bear	West Indian Manatee	Ringed Seal
Acoustic Stressors											
Sonar and Other Active Acoustic Sources	Training Activities	May affect likely to adversely affect	No effect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
	Testing Activities	May affect likely to adversely affect	No effect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
Explosives	Training Activities	May affect likely to adversely affect	No effect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect not likely to adversely affect	May affect likely to adversely affect	No effect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect not likely to adversely affect	May affect likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
Pile Driving	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect	No effect	No effect	May affect not likely to adversely affect	No effect
	Testing Activities	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Swimmer Defense Airguns	Training Activities	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Testing Activities	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	May affect not likely to adversely affect	No effect
Weapons Firing, Launch, and Impact Noise	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
Aircraft Noise	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
Vessel Noise	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
Energy Stressors											
Electromagnetic	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
High Energy Lasers	Training Activities	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Testing Activities	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect

Table 3.4-37: Endangered Species Act Determinations for Training and Testing Activities for the Preferred Alternative (Alternative 2) (Continued)

Stressor		North Atlantic Right Whale	Bowhead Whale	Humpback Whale	Sei Whale	Fin Whale	Blue Whale	Sperm Whale	Polar Bear	West Indian Manatee	Ringed Seal
Physical Disturbance and Strike Stressors											
Vessels	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
In-Water Devices	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
Military Expended Materials	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
Seafloor Devices	Training Activities	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
	Testing Activities	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Entanglement Stressors											
Fiber Optic Cables and Guidance Wires	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
Parachutes	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
Ingestion Stressors											
Munitions	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
Military Expended Materials Other Than Munitions	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
Secondary Stressors											
Secondary Stressors	Training	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
	Testing	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect

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3.5 Sea Turtles and Other Marine Reptiles

SEA TURTLES AND OTHER MARINE REPTILES SYNOPSIS

The Navy considered all potential stressors and the following have been analyzed for sea turtles and other marine reptiles:

- Acoustic (sonar and other active acoustic sources, explosives, pile driving, swimmer defense airguns, weapons firing, launch, and impact noise, and aircraft and vessel noise)
- Energy (electromagnetic devices, high energy lasers)
- Physical disturbance and strike (vessels, in-water devices, military expended materials, seafloor devices)
- Entanglement (fiber optic cables, guidance wires, and parachutes)
- Ingestion (munitions and military expended materials other than munitions)
- Secondary (explosives and byproducts, metals, and chemicals)

Preferred Alternative

- Acoustics: Pursuant to the Endangered Species Act (ESA), the use of sonar, other active sources, and explosives may affect and is likely to adversely affect ESA-listed sea turtles; and may affect but is not likely to adversely affect the American crocodile or American alligator. Pile driving, swimmer defense airguns and weapons firing noise may affect but are not likely to adversely affect ESA-listed sea turtles; and will have no effect on the American crocodile or American alligator. Aircraft and vessel noise may affect but is not likely to adversely affect ESA-listed sea turtles, the American crocodile, or the American alligator. Acoustic stressors will have no effect on critical habitat for any ESA-listed marine reptiles.
- Energy: Pursuant to the ESA, the use of electromagnetic devices may affect but is not likely to adversely affect ESA-listed sea turtles; and will have no effect on the American crocodile or American alligator. The use of high energy lasers will have no effect on any ESA-listed sea turtle species, the American alligator, or the American crocodile. The use of electromagnetic devices and high energy lasers will have no effect on critical habitat for any ESA-listed marine reptile.
- Physical Disturbance and Strike: Pursuant to the ESA, vessel use may affect and is likely to adversely affect ESA-listed sea turtles. The use of in-water devices and military expended materials may affect but is not likely to adversely affect ESA-listed sea turtles. The use of vessels, in-water devices, and military expended materials will have no effect on the American crocodile or American alligator. The use of vessels, in-water devices, and military expended materials will have no effect on critical habitat for any ESA-listed marine reptiles.
- Entanglement: Pursuant to the ESA, the use of fiber optic cables, guidance wires, and parachutes may affect but is not likely to adversely affect ESA-listed sea turtles; and will have no effect on the American crocodile or American alligator.
- Ingestion: Pursuant to the ESA, the use of munitions with the potential for ingestion may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, and loggerhead sea turtles; and will have no effect on the leatherback sea turtle, American crocodile, or American alligator. The potential for ingestion of military expended materials other than munitions may affect but is not likely to adversely affect ESA-listed sea turtles; and will have no effect on the American crocodile or American alligator.
- Secondary: Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect ESA-listed sea turtles, the American crocodile, or the American alligator and will have no effect on critical habitat for any ESA-listed marine reptile.

3.5.1 INTRODUCTION

This section provides a brief introduction to sea turtles and other marine reptiles that occur within the boundaries of the Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area) and whose distribution may overlap with stressors associated with the Proposed Action. As shown in Table 3.5-1, there are five species of sea turtles, the American crocodile (*Crocodylus acutus*), and the American alligator (*Alligator mississippiensis*) which occur within the Study Area; all are listed under the Endangered Species Act (ESA) as either threatened or endangered. The National Marine Fisheries Service (NMFS) and the United States (U.S.) Fish and Wildlife Service share jurisdictional responsibility for sea turtles under the ESA. The U.S. Fish and Wildlife Service has responsibility in the terrestrial environment (e.g., nesting beaches), while NMFS has responsibility in the marine environment. Jurisdictional management of the American crocodile and American alligator is the responsibility of the U.S. Fish and Wildlife Service.

Sea turtles are found in coastal waters and on nesting beaches of the U.S. Atlantic Coast, Gulf of Mexico, Caribbean Sea, and in open ocean areas. The American crocodile and American alligator occur in fresh and brackish waters, and are occasionally observed in nearshore marine waters. Each species is discussed further in Section 3.5.2 (Affected Environment).

The olive ridley sea turtle (*Lepidochelys olivacea*) was considered for inclusion in this document, but because its occurrence in the Study Area is extralimital (outside the species' normal range), the species will not be analyzed. Western Atlantic olive ridley sea turtle populations are centered near Suriname/French Guiana and Brazil. Olive ridleys are not known to move among ocean basins. Within a region, they move only occasionally between the ocean and coastal zone, usually remaining in coastal waters (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007e). Occurrences as far north as Puerto Rico, the Dominican Republic, and Cuba are considered rare. Between 1999 and 2001, three individuals were reported in coastal south Florida; however, all were strandings (Foley et al. 2003). The two turtles sighted in the Florida Keys were floating and debilitated with net entanglement injuries. The third was a dead turtle found covered in tar on a beach in Miami. These are the first known sightings in Florida and the northernmost occurrences of olive ridleys in the western North Atlantic. These sightings are considered extralimital occurrences because these fatally injured turtles were likely carried outside of their range by vessels or currents, and genetic analysis confirmed that these three turtles were members of the Suriname/French Guiana population (Foley et al. 2003). Currently, there are no olive ridley nesting beaches in the eastern United States, and there are no known feeding, breeding, or migration areas within the Study Area; therefore, there does not appear to be a nexus between olive ridley sea turtles and U.S. Department of the Navy (Navy) training and testing activities.

3.5.2 AFFECTED ENVIRONMENT

Sea turtles are highly migratory, long-lived reptiles that occur throughout the open-ocean and coastal regions of the Study Area, generally within tropical to subtropical latitudes. Leatherbacks (*Dermochelys coriacea*), because of their unique physiology among sea turtles, occur with more regularity in colder waters at higher latitudes (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991; Prescott 2000). Habitat and distribution vary depending on species and life stages and is discussed further in the species profiles.

Little information is available regarding a sea turtle's stage of life after hatching. Open-ocean juveniles spend an estimated 2 to 14 years drifting, foraging, and developing. Due to the general lack of knowledge of this period, it has been described as "the lost years." After this period, juvenile

Table 3.5-1: Regulatory Status and Presence of Endangered Species Act–Listed Sea Turtles and Other Marine Reptiles in the Study Area

Species Name and Regulatory Status			Presence in Study Area		
Common Name	**Scientific Name**	**Endangered Species Act Status**	**Open Ocean Area**	**Large Marine Ecosystem[1]**	**Bays, Rivers, and Estuaries**
Family Cheloniidae (hard-shelled sea turtles)					
Green Turtle	*Chelonia mydas*	Threatened/ Endangered[2]	North Atlantic Subtropical Gyre, Gulf Stream	Northeast U.S. Continental Shelf*, Southeast U.S. Continental Shelf*, Caribbean Sea*, Gulf of Mexico*	Narragansett Bay, Kings Bay, Port Canaveral, St. Andrew Bay, Corpus Christi Bay
Hawksbill Turtle	*Eretmochelys imbricata*	Endangered	North Atlantic Subtropical Gyre, Gulf Stream	Northeast U.S. Continental Shelf[3], Southeast U.S. Continental Shelf*, Caribbean Sea*, Gulf of Mexico*	–
Kemp's Ridley Turtle	*Lepidochelys kempii*	Endangered	North Atlantic Subtropical Gyre, Gulf Stream	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf*, Caribbean Sea, Gulf of Mexico*	Narragansett Bay, Chesapeake Bay, Corpus Christi Bay
Loggerhead Turtle	*Caretta caretta*	Threatened/ Endangered[4]	North Atlantic Subtropical Gyre, Gulf Stream	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf*, Southeast U.S. Continental Shelf*, Caribbean Sea*, Gulf of Mexico*	Narragansett Bay, Delaware Bay, Chesapeake Bay, St. Andrew Bay, Kings Bay, Port Canaveral
Family Dermochelyidae (leatherback sea turtle)					
Leatherback Turtle	*Dermochelys coriacea*	Endangered	North Atlantic Subtropical Gyre, Gulf Stream	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf*, Southeast U.S. Continental Shelf*, Caribbean Sea*, Gulf of Mexico*	Narragansett Bay, Chesapeake Bay, Port Canaveral
Family Crocodylidae (true crocodiles)					
American Crocodile	*Crocodylus acutus*	Threatened	–	Southeast U.S. Continental Shelf*, Gulf of Mexico*	–
American Alligator	*Alligator mississippiensis*	Threatened due to similarity of appearance**	–	Southeast U.S. Continental Shelf*, Gulf of Mexico*	Kings Bay, Port Canaveral, St. Andrew Bay, Corpus Christi Bay

Sources: Federal Register [FR] 35 (233): 18319-18322, December 2, 1970; FR 35 (106): 8491-8498, June 2, 1970; FR 43 (146): 32800-32811, July 28, 1978; FR 76 (184): 58868-58952, September 22, 2011.

* Nesting occurs within this large marine ecosystem.

** The American alligator is listed under the Endangered Species Act (ESA) classification of "threatened due to similarity of appearance" to the American crocodile.

1 The large marine ecosystems of the Study Area are characterized by coastal waters.

2 As a species, the green turtle is listed under the ESA as threatened, but the Florida and Mexican Pacific coast nesting populations are listed as endangered. Note that green turtles found in the Study Area might not all be from the Florida population.

3 Hawksbills have been recorded here rarely; occurrence in the Northeast U.S. Continental Shelf Large Marine Ecosystem is extralimital (outside of their normal range).

4 Nine distinct population segments exist for loggerhead sea turtles. 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 listed as endangered under the ESA. The Southeast Indo-Pacific Ocean, Southwest Indian Ocean, Northwest Atlantic Ocean, and South Atlantic Ocean distinct population segments are listed as threatened under the ESA. Of these, the Northwest Atlantic Ocean distinct population segment is the only one that occurs entirely in the Study Area.

hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), loggerhead (*Caretta caretta*), and green (*Chelonia mydas*) sea turtles settle into coastal habitat, with individuals often remaining faithful to a specific home range until adulthood (Bjorndal and Bolten 1988; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991). Leatherback turtles remain primarily in the open ocean throughout their lives, except for mating in coastal waters and females going ashore to lay eggs. All species have the ability to migrate long distances across large expanses of the open ocean, primarily between nesting and feeding grounds (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

All sea turtle species are believed to use a variety of orientation mechanisms on land and at sea (Lohmann et al. 1997). After emerging from the nest, hatchling turtles use visual cues, such as light wavelengths and shape patterns, to find the ocean (Lohmann et al. 1997; Salmon et al. 1992). Once in the ocean, hatchlings use wave cues to navigate offshore (Lohmann and Lohmann 1992). In the open ocean, turtles in all life stages are thought to orient to the earth's magnetic field to position themselves in oceanic currents; this helps them locate seasonal feeding and breeding grounds and return to their nesting sites (Benhamou et al. 2011; Lohmann and Lohmann 1996b; Lohmann et al. 1997). The stimuli that help sea turtles find their nesting beaches are still poorly understood, particularly the fine-scale navigation that occurs as turtles approach the site, and could also include chemical and acoustic cues.

Crocodilians (alligators and crocodiles) are long-lived reptiles. They are ectotherms ("cold-blooded"), meaning they rely on external sources of heat to regulate their body temperature. Crocodilians control their body temperature by basking in the sun or moving to areas with warmer or cooler air and water temperatures. The American crocodile inhabits freshwater, including rivers, lakes, and reservoirs, and can also be found in brackish environments such as estuaries and swamps (Fishman et al. 2009), and occurs within the Study Area in coastal portions of the Caribbean and in Florida. The Florida population marks the northern extent of this species' range and is classified as a distinct population segment due to its genetic isolation (U.S. Fish and Wildlife Service 2010). American alligators are usually found in freshwater, in slow moving rivers, or in the brackish waters of swamps, marshes, and lakes. They can tolerate saltwater for only brief periods because they do not have salt glands (Britton 2009). The alligator is found throughout the southeastern United States, from the Carolinas to Texas (U.S. Fish and Wildlife Service 2008). Neither species occurs in offshore oceanic waters.

3.5.2.1 Diving

While the American crocodile and the American alligator do submerge, they do not dive in the traditional sense; thus these species are not discussed in this section.

3.5.2.1.1 Sea Turtles

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 and monitoring. In addition, their relative distribution through the water column is an important consideration when conducting acoustic exposure analyses. Information and data on diving behavior for each species of sea turtle was compiled in a technical report (Watwood and Buonantony 2012) that provides a detailed summary of time at depth used for the purpose of distributing animals through the water column within the acoustic exposure model. The following text below briefly summarizes the dive behavior of each species.

Green turtle. In the open ocean, Hatase et al. (2006) observed that adult green turtles dive to a maximum of 260 feet (ft.), or 80 meters (m). Open-ocean resting dives rarely exceed 50 ft. (15 m), while most open-ocean foraging dives average about 80 ft. (25 m) (Hatase et al. 2006). While studying migrations of green turtles between the Northwest and the main Hawaiian Islands, Rice and Balazs (2008) noted a difference between night and day dives in both their duration and depth. During the day, dives lasted between 1 and 18 minutes and rarely exceeded 14 ft. (4 m) in depth. At night, green turtles began a pattern consisting of deep dives, with a mean duration of 35 to 44 minutes and a mean maximum dive depth of 115 to 164 ft. (35 to 55 m) (Rice and Balazs 2008). During this study, an adult female made two nocturnal dives in excess of 443 ft. (135 m), which represent the deepest dives ever recorded for this species. In their coastal habitat, green turtles (adults) typically make dives shallower than 100 ft. (30 m), with most dives not exceeding 58 ft. (17.5 m) (Hays et al. 2004; Rice and Balazs 2008). Green turtles are known to forage and also rest at depths of 65 to 165 ft. (20 to 50 m) (Balazs 1980; Brill et al. 1995).

Hawksbill turtle. Adult hawksbill turtles make short, active foraging dives during the day, while longer resting dives occur at night (Blumenthal et al. 2009; Storch et al. 2005; Van Dam and Diez 1996). Starbird et al. (1999) reported that during inter-nesting periods, adult females' dives at Buck Island, U.S. Virgin Islands averaged 56.1 minutes in duration. Lutcavage and Lutz (1997) cited a maximum dive duration of 73.5 minutes for a female hawksbill in the U.S. Virgin Islands. Van Dam and Diez (1996) reported that foraging dives at a study site in the northern Caribbean ranged from 19 to 26 minutes at depths of 25 to 35 ft. (8 to 10 m), with resting night dives ranging from 35 to 47 minutes (Van Dam and Diez 1996). Foraging dives of immature hawksbills are of shorter duration, ranging from 8.6 to 14 minutes (Van Dam and Diez 1996), with a mean and maximum depth of 5 ft. (1.5 m) and 65 ft. (20 m), respectively (Blumenthal et al. 2009; Van Dam and Diez 1996).

Kemp's ridley turtle. In shallow summer foraging waters of the Atlantic Ocean, juveniles remain submerged during the day, generally feeding on the bottom (National Marine Fisheries Service 2010). Sasso and Witzell (2006) reported longer dives at night than during the day for this species. In offshore waters, juvenile Kemp's ridley turtles dove less than 49 ft. (15 m) regardless of bottom depth, with generally longer surface intervals than exhibited in coastal waters. Dive times ranged from a few seconds to 167 minutes, with routine dives lasting between 16.7 and 33.8 minutes (Mendonça and Pritchard 1986; Renaud 1995). Submergence time varies seasonally; dives are longest during the winter (greater than 30 minutes), and during the remainder of the year, dives are 15 minutes (Renaud and Williams 2005). Over a 12-hour period, Kemp's ridley turtles spend as much as 96 percent of their time submerged (Gitschlag 1996; Sasso and Witzell 2006). In Cedar Keys, Florida, the mean surface duration was 18 seconds, while submergence duration was 8.4 minutes (Schmid et al. 2002).

Loggerhead turtle. Studies of loggerhead diving behavior indicate varying mean depths and surface intervals, depending on whether they were located in shallow coastal waters (short surface intervals) or in deeper, offshore areas (longer surface intervals) (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009). Loggerhead turtles foraging in the nearshore habitat dive to the seafloor (average depth 165–490 ft. [50–150 m]), and those in the open-ocean habitat dive in the 0–80 ft. (0–25 m) depth range (Hatase et al. 2007). Dive duration was significantly longer at night and increased in warmer waters. The average overall dive duration was 25 minutes, although dives exceeding 300 minutes were recorded. Turtles in the open-ocean habitat exhibited mid-water resting dives at around 45 ft. (14 m), where they could remain for many hours. This appears to be the main function of many of the night dives recorded (Hatase et al. 2007). Another study on coastal foraging loggerheads by Sakamoto et al. (1993) found that virtually all dives were shallower than 100 ft. (30 m).

Immature loggerheads and adults in neritic habitats can spend more than 90 percent of their time underwater (Byles 1988; Renaud and Carpenter 1994). Studies investigating dive characteristics of loggerheads under various conditions confirm that loggerheads do not dive particularly deep in the open-ocean environment (about 80 ft. [25 m]) but will forage to bottom depths of at least 490 ft. (150 m) in coastal habitats (Hatase et al. 2007; Polovina et al. 2003; Soma 1985).

Leatherback turtle. The leatherback is the deepest diving sea turtle with a recorded maximum depth of 4,200 ft. (1,280 m), although most dives are much shallower, usually less than 820 ft. (250 m) (Hays et al. 2004; Sale et al. 2006). Diving activity (including surface time) is influenced by a suite of environmental factors (e.g., water temperature, availability and vertical distribution of food resources, bathymetry) that result in spatial and temporal variations in dive behavior (James et al. 2006; Sale et al. 2006). Leatherbacks dive deeper and longer in the lower latitudes versus the higher latitudes (James et al. 2005a; James et al. 2005b), where they are known to dive in waters with temperatures just above freezing (James et al. 2006; Jonsen et al. 2007). James et al. (2006) noted that dives in higher latitudes are punctuated by longer surface intervals and more time at the surface, perhaps in part to regulate body temperature (i.e., bask). Tagging data also revealed that changes in individual turtle diving activity appear to be related to water temperature, suggesting an influence of seasonal prey availability on diving behavior (Hays et al. 2004). While transiting, leatherbacks make longer and deeper dives (James et al. 2006; Jonsen et al. 2007). It is suggested that leatherbacks make scouting dives while transiting as an efficient means for sampling prey density and perhaps also to feed opportunistically at these times (James et al. 2006; Jonsen et al. 2007). In the Atlantic, Hays et al. (2004) determined that migrating and foraging adult leatherbacks spent 71 to 94 percent of their diving time at depths from 230 to 361 ft. (70 to 110 m).

During nesting, dive depths are likely constrained by the bathymetry adjacent to the nesting site (Myers and Hays 2006). For example, patterns of relatively deep diving are recorded off St. Croix in the Caribbean (Eckert et al. 1986) and Grenada (Myers and Hays 2006) in areas where deep waters are close to shore. A maximum depth of 1,560 ft. (475 m) was recorded (Eckert et al. 1986), although even deeper dives were inferred where dives exceeded the maximum range of the time depth recorder (Eckert et al. 1989b). Shallow diving occurs where shallow water is close to the nesting beach in areas such as the China Sea (Eckert et al. 1996), Costa Rica (Southwood et al. 1999), and French Guiana (Fossette et al. 2007).

3.5.2.2 Hearing and Vocalization

3.5.2.2.1 Sea Turtles

The auditory system of the sea turtle appears to work via water and bone conduction, with lower frequency sound conducted through to skull and shell, and does not appear to function well for hearing in air (Lenhardt 1982; Lenhardt et al. 1983). Sea turtles do not have external ears (pinnae) or ear canals to channel sound to the middle ear, nor do they have a specialized eardrum. Rather, sound is conducted through the shell and bone to the inner ear (Lenhardt et al. 1983). Fibrous and fatty tissue layers on the side of the head may serve as a sound-receiving tympanic membrane in the sea turtle, a function similar to that of the eardrum in mammals, but more likely dampen vibrations received via bone conduction at the inner ear (Lenhardt et al. 1983). The columella, a thin bone connecting the fatty tissues of the tympanum to the oval window at the inner ear, applies a dampening load to the oval window, and may also assist detection of vibrations by inertial displacement (Lenhardt et al. 1985). Unlike mammals, the cochlea of the sea turtle is not elongated and coiled and likely does not respond well to high frequencies, a hypothesis supported by the limited amount of research on sea turtle auditory sensitivity (Bartol et al. 1999; Ridgway et al. 1969).

Investigations suggest that sea turtle auditory sensitivity is limited to low-frequency bandwidths, such as the sounds of waves breaking on a beach. The role of underwater low-frequency hearing in sea turtles is unclear. Sea turtles may use acoustic signals from their environment as guideposts during migration and as cues to identify their natal beaches (Lenhardt et al. 1983). Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hertz (Hz), with a range of maximum sensitivity between 100 and 800 Hz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 2002; Lenhardt 1994; Martin et al. 2012; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still potentially usable (Lenhardt 1994). Greatest sensitivities are 300 to 400 Hz for the green turtle (Ridgway et al. 1969) and around 250 Hz or below for juvenile loggerheads (Bartol et al. 1999). Bartol et al. (1999) reported that the range of effective hearing for juvenile loggerhead turtles is from at least 250 to 750 Hz using the auditory brainstem response technique. Behavioral and audio evoked potential audiogram methods showed an adult loggerhead to have best sensitivity between 100 and 400 Hz, with no detection of 1131 Hz tones via the behavioral method (Martin et al. 2012). Juvenile and sub-adult green turtles detect sounds from 100 to 500 Hz underwater, with maximum sensitivity at 200 and 400 Hz (Bartol and Ketten 2006). Auditory brainstem response recordings on green turtles showed peak response at 300 Hz (Yudhana et al. 2010). Juvenile Kemp‘s ridley turtles were found to detect underwater sounds from 100 to 500 Hz, with a maximum sensitivity between 100 and 200 Hz (Bartol and Ketten 2006). There is a lack of audiometric information for leatherback turtles; however, their anatomy suggests they would hear similarly to other sea turtles. Functional hearing of all species of sea turtles, for the purposes of this analysis, is assumed to be 10 Hz to 2 kilohertz (kHz).

Few sea turtles have been tested to determine auditory thresholds. Sub-adult green turtles show, on average, the lowest hearing threshold at 300 Hz (93 decibels [dB] referenced to (re) 1 micropascal [µPa]), with thresholds increasing at frequencies above and below 300 Hz, when thresholds were determined by auditory brainstem response (Bartol and Ketten 2006). Auditory brainstem response testing was also used to detect thresholds for juvenile green turtles (lowest threshold 93 dB re 1 µPa at 600 Hz) and juvenile Kemp's ridley turtles (thresholds above 110 dB re 1 µPa across hearing range)(Bartol and Ketten 2006). Auditory thresholds for yearling and two-year old loggerhead sea turtles were also recorded. Both yearling and two-year old loggerheads had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re 1 µPa and two-year-olds: about 86 dB re 1 µPa), with thresholds increasing rapidly above and below that frequency (Bartol and Ketten 2006). An adult loggerhead exhibited behavioral thresholds between 98 and 106 dB re 1 µPa and electrophysiological thresholds between 110 and 112 dB re 1 µPa over its best hearing range of 100 to 400 Hz, with thresholds rapidly increasing over 400 Hz in both cases (Martin et al. 2012). Electrophysiological audiometry techniques used in the above studies measure small electrical voltages produced by neural activity when the auditory system is stimulated by sound but do not measure behavioral responses to sounds.

Sea turtles are only known to produce sounds during nesting. Nesting leatherback turtles were recorded producing sounds (sighs or belch-like sounds) up to 1,200 Hz with most energy ranging from 300 to 500 Hz (Mrosovsky 1972).

3.5.2.2.2 Crocodilians (Crocodiles and Alligators)

Overall, crocodilians (crocodiles and alligators), like other amphibious species, have both in-air and underwater hearing capabilities. However, crocodilians appear to be structurally adapted for detection of airborne sound based on the similarities between crocodilian and avian ear morphology and the corresponding auditory brainstem structures (Gleich and Manley 2000).

While crocodilians detect airborne sound via the tympanic membrane, sounds in water appear to be detected via bone conduction (Higgs et al. 2002). Crocodilians have external muscular flaps (ear lids) both above and below the opening of the external auditory canal that reflexively seal off the canal when submerged and then relax above water (Wever 1971).

Crocodilian hearing is most sensitive at lower frequencies, both in air and in water. Ranges and thresholds of sound detection have not been studied for adult crocodilians but have been studied in juveniles. A study of young crocodilians showed best in-air hearing sensitivity from 100 to 1,000 Hz (American alligator) and 100 to 3,000 Hz (American crocodile) using electrophysiological measures (Wever 1971). Evaluation of in-air hearing sensitivity of juvenile American crocodiles using auditory brainstem response showed responses to sounds from 100 Hz to 8 kilohertz (kHz)(Higgs et al. 2002). The best hearing range between 1 and 1.5 kHz was similar to the previous study, with lowest thresholds around 36 to 38 dB re 20 µPa and poor sensitivity above 2 kHz (Higgs et al. 2002). In water, auditory brainstem responses by juvenile American crocodiles were observed during sound exposures from 100 Hz to 2 kHz, with best sensitivity at 800 Hz (about 85 dB re 1 µPa), and no responses to exposures at 4 kHz (Higgs et al. 2002). Electrophysiological audiometry techniques used in the above studies measure small electrical voltages produced by neural activity when the auditory system is stimulated by sound but do not measure behavioral responses to sounds.

With regard to sound production, crocodilian calls are typically low-frequency, short, and repetitive. Types of calls include bellows at the air-water interface (20 to 250 Hz), grunts (up to one kHz), hisses, and coughs, with bellows having a notable in-water component (Vergne et al. 2009). Adult American alligators make a variety of communication sounds, including infrasonic signals at the air-water interface (Garrick and Lang 1977), bellows with a dominant frequency around 100 Hz with harmonics up to 400 Hz (Vliet 1989), and a broadband hiss during threat displays (Garrick et al. 1978). Hatchling and juvenile alligators such as those used in the auditory studies discussed above have a more restricted communication repertoire (Higgs et al. 2002).

3.5.2.3 General Threats

The discussion below represents general threats to sea turtles and crocodilians. Additional threats to individual species within the Study Area are described below in the accounts of those species.

3.5.2.3.1 Sea Turtles

Many threats are common among all sea turtle species. Bycatch in commercial fisheries, ship strikes, and marine debris (Triessnig et al. 2012) are some of the primary threats to sea turtles (Lutcavage et al. 1997). One comprehensive study estimates that worldwide, 447,000 sea turtles are killed each year from bycatch in commercial fisheries (Wallace et al. 2010). 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 et al. 1997). Marine debris can also be a problem for sea turtles through entanglement or ingestion (Lazar and Gracan 2011; Macedo et al. 2011). Sea turtles can mistake debris for prey; one study found 37 percent of dead leatherback turtles to have ingested various types of plastic (Mrosovsky et al. 2009). Plastic ingestion was identified as the cause of death in 9 percent of these cases. Other marine debris, including derelict fishing gear and cargo nets, can entangle and drown turtles in all life stages.

On beaches, wild and domestic dogs, feral pigs, raccoons, and other predators ravage sea turtle nests and emerging hatchlings. In some parts of the world, humans continue to harvest eggs and nesting females (Maison et al. 2010; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a). Habitat destruction or degradation is also an issue for sea turtles. Coastal development can cause beach erosion and introduce invasive vegetation, destroying or rendering nesting habitat inaccessible. It can also create or increase the intensity of artificial light, which confuses hatchlings and increases their mortality rates (National Marine Fisheries Service 2010). In aquatic habitats, degradation issues such as poor water quality and invasive species can alter ecosystems, limit food availability, and decrease survival rates (National Marine Fisheries Service 2010). Environmental degradation can also increase susceptibility to diseases such as fibropapillomatosis, a debilitating tumor-forming disease that primarily affects green turtles (Santos et al. 2010).

Global climate change, with predictions of increased ocean and air temperatures as well as sea level rise, may also negatively affect turtles in all life stages from egg to adult (Griffin et al. 2007; Poloczanska et al. 2009; Santidrián Tomillo et al. 2012; Witt et al. 2007). Potential impacts include embryo death caused by high nest temperatures, skewed sex ratios because of increased sand temperature, loss of nesting habitat due to beach erosion, coastal habitat degradation (e.g., coral bleaching and disease), and spatial shifts in suitable habitat, as well as alteration of the marine food web (Doney et al. 2012), which can decrease the amount of prey species.

Of particular note to sea turtles in the Gulf of Mexico is the 2010 BP *Deepwater Horizon* oil spill, the impacts of which are only beginning to be understood. Oil impacts on turtles include increased egg mortality and developmental defects; direct deaths resulting from oil exposure in hatchlings, juveniles, and adults; direct deaths due to spill containment efforts; and negative impacts on the skin, blood, digestive and immune systems, and salt glands (Milton et al. 2010). Sea turtles continually surface to breathe, and as they rapidly inhale air before diving they may inhale petroleum fumes or ingest oil floating on the water's surface (Milton et al. 2010). Several agencies conducted missions to rescue and rehabilitate sea turtles harmed by the oil spill (Restore The Gulf 2010). For example, during the 2010 nesting season, eggs from loggerhead turtle nests in the Florida panhandle and Alabama were collected and transported to the east coast of Florida, and the hatchlings were released into the Atlantic Ocean near Cape Canaveral. As of August 2010, more than 14,000 hatchlings had been released (Restore The Gulf 2010). According to preliminary data through 15 February 2011, 537 juvenile and adult turtles have been recovered alive and 609 have been found dead during rescue efforts in the Gulf of Mexico. Data were compiled from both strandings and offshore captures, and necropsies are currently being completed to determine the exact causes of death (National Marine Fisheries Service 2011a). Species found were green, hawksbill, Kemp's ridley, and loggerhead turtles; the majority of these were Kemp's ridley turtles (328 alive, 481 dead). At the time of this writing, research is ongoing in an attempt to learn more about the oil spill's long-term impacts on sea turtles and their habitats in the Gulf of Mexico.

Detailed descriptions of threats in the nesting and marine environment, as well as the seriousness of each threat, can be found in the sea turtle recovery plans for each species that occurs in U.S. waters (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991, 1992a, b, 1993, 1998c, 2009). These recovery plans are used as a primary source of information regarding each sea turtle species' population status and threats (Sections 3.5.2.4 through 3.5.2.8).

3.5.2.3.2 Crocodilians

Habitat loss is a primary threat to the American crocodile and the American alligator. Human development diminishes crocodilian habitat and restricts the species' breeding range. In addition to direct habitat loss, alteration of habitat is a concern as water management programs are developed. Development restricts freshwater flow into swamps and estuaries, which may limit crocodilian growth, survival, and abundance (Mazzotti et al. 2007). Erosion, water contaminants, and sea level rise may further increase vulnerability of nesting sites for both species (Mazzotti et al. 2007; Savannah River Ecology Laboratory 2012b). Short-term effects on crocodilians and their habitat also include the potential impacts caused by hurricanes (Elsey et al. 2006; Elsey and Woodward 2010). Detailed information about threats to these species and life history information can be found in the ESA listing documentation and their recovery plans (FR 44 (244): 75074-75076, December 18, 1979; FR 52 (107): 21059-21064, June 4, 1987; FR 72 (53): 13027-13040, March 20, 2007; (U.S. Fish and Wildlife Service 1999).

The sections that follow contain specific details on the five species of sea turtles, the American crocodile, and the American alligator, and their occurrence in the Study Area.

3.5.2.4 Green Sea Turtle (*Chelonia mydas*)

3.5.2.4.1 Status and Management

The green sea turtle is listed as two populations under the ESA: the Florida and Mexico Pacific coast breeding colonies, and sea turtles from all other populations. The Florida and Mexico Pacific coast breeding colonies are designated as endangered and all other colonies are designated as threatened (FR 43 (146): 32800-32811, July 28, 1978). Individuals from both populations may be present in the Study Area. As of the 2007 status report, NMFS and the U.S. Fish and Wildlife Service determined that the current population listing remains valid and green turtles will not undergo a distinct population segment analysis (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a). In 1998, critical habitat was designated for green sea turtles in coastal waters around Culebra Island, Puerto Rico, from the mean high water line seaward to 3 nautical miles (nm) to include Culebra’s outlying Keys as shown in Figure 3.5-1 (FR 63 (170): 46693-46701, September 2, 1998). The essential physical and biological features of this critical habitat include (1) seagrass beds, which provide valuable foraging habitat; (2) coastal waters of Culebra, which serve as a developmental habitat and support juvenile, subadult, and adult green sea turtle populations; and (3) coral reefs and other topographic features that provide shelter (FR 63 (170): 46693-46701, September 2, 1998).

3.5.2.4.2 Habitat and Geographic Range

The green sea turtle is distributed worldwide across tropical and subtropical coastal waters between 45° N and 40° S (The State of the World's Sea Turtles Team 2011). After emerging from the nest, green turtle hatchlings swim to offshore areas where they float passively in major current systems. Post-hatchling green turtles forage and develop in floating *Sargassum* habitats of the open ocean. At the juvenile stage (estimated at 5 to 6 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 and Bolten 1988). The optimal developmental habitats for late juveniles and foraging habitats for adults are warm shallow waters (3–5 m [10–16 ft.] deep), with abundant submerged aquatic vegetation and close to nearshore reefs or rocky areas (Holloway-Adkins 2006; Seminoff et al. 2002).

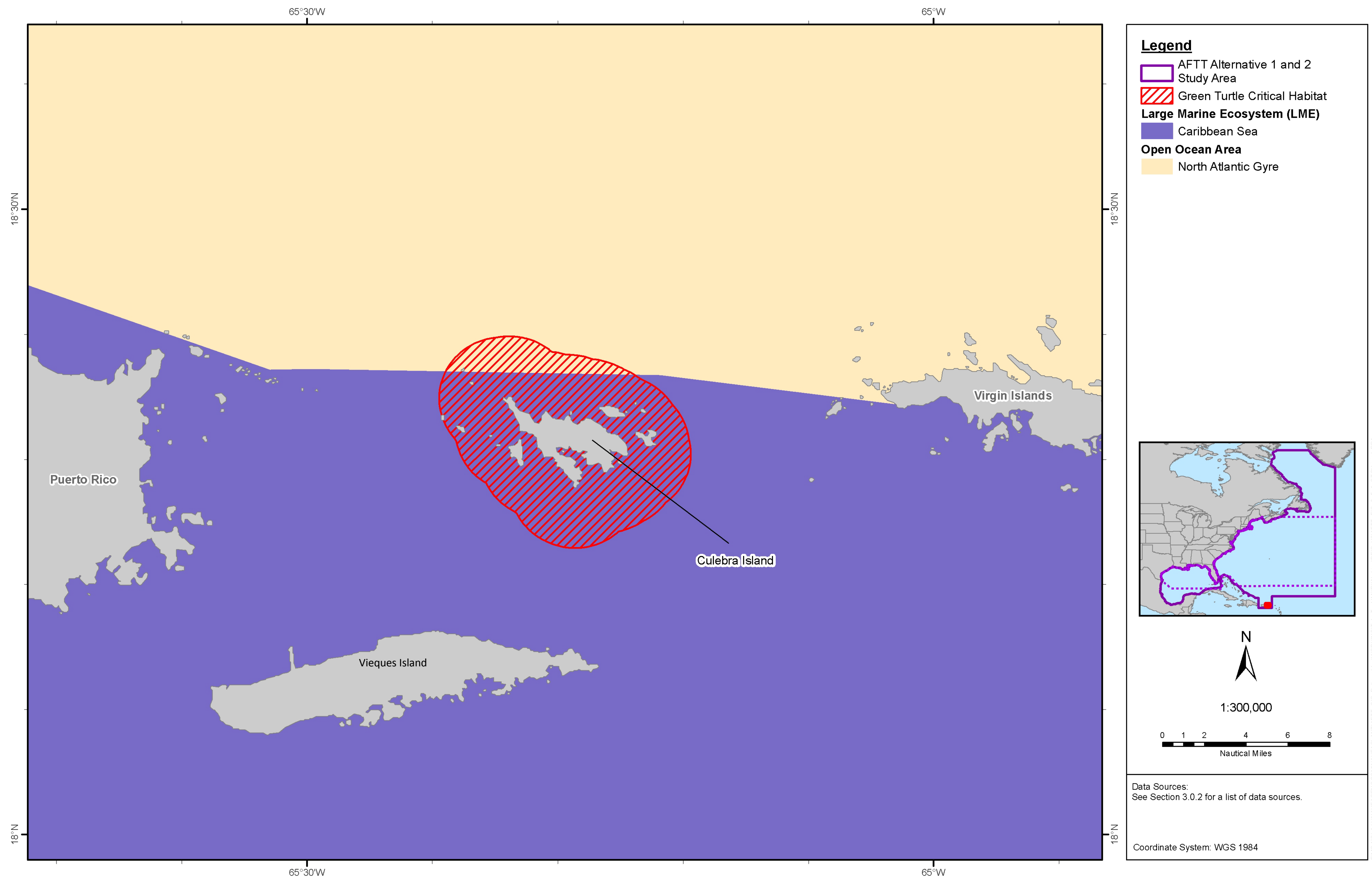

Figure 3.5-1: Critical Habitat Areas for Green Sea Turtles in the Study Area
AFTT: Atlantic Fleet Training and Testing

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When green sea turtles reach sexual maturity, they begin breeding migrations between foraging grounds and nesting areas every few years (Hirth 1997). Both males and females migrate, often traversing geographically disparate habitats and crossing ocean basins that span thousands of miles (Carr 1986, 1987; Mortimer and Portier 1989). Female green sea turtles return to their natal beaches to nest every two to five years (Hirth 1997). Nesting season varies with locality; in the Study Area, the season is roughly June to September (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a). Moderate green turtle nesting occurs in the southeastern contiguous United States, Puerto Rico, and the U. S. Virgin Islands. Green sea turtles often return to the same foraging areas after subsequent nesting migrations (Godley et al. 2002; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a), where they have specific home ranges and movement patterns (Seminoff et al. 2002). During nonbreeding periods, adults reside in coastal nearshore feeding areas that sometimes correspond with juvenile developmental habitats (Marine Turtle Specialist Group 2004). Regardless of the chosen habitat for any given age class of green turtles, all exhibit high fidelity to foraging home ranges (Bresette et al. 1998; Makowski et al. 2006).

Gulf Stream and North Atlantic Gyre Open Ocean Areas. Green sea turtles are known to live in the open-ocean waters of the Gulf Stream and North Atlantic Gyre during the first 5–6 years of life, but little is known about preferred habitat or general distribution during this life phase beyond the information presented in the introduction to this resource. Information on migratory routes within this area is limited. The main source of information on distribution in the Study Area comes from U.S. fisheries bycatch.

Northeast U.S. Continental Shelf Large Marine Ecosystem. As ocean temperatures increase in the spring, green sea turtles migrate from southeastern U.S. waters to the estuarine habitats of Long Island Sound, Peconic Bay, and possibly Nantucket Sound, where an abundance of algae and eelgrass occurs (Lazell 1980; Morreale and Standora 1998). Peak occurrence in the Northeast U.S. Continental Shelf Large Marine Ecosystem is likely in September (Berry et al. 2000). During nonbreeding periods, adult and juvenile distributions may overlap in coastal feeding areas (Hirth 1997).

Southeast U.S. Continental Shelf Large Marine Ecosystem. Juvenile green turtles are the second-most abundant sea turtle species in North Carolina summer developmental habitats, occurring year-round within continental shelf waters, while adults are restricted to more southern latitudes (Epperly et al. 1995c). Most green sea turtle sightings north of Florida are of juveniles and occur during late spring to early fall (Burke et al. 1992; Epperly et al. 1995a; Lazell 1980).

During in-water research projects conducted at sites around Florida, the green sea turtle was the second-most frequently captured species after the loggerhead in northwest Florida, along the west coast, and on the east coast. The majority of captured green sea turtles were juveniles; subadult and adult turtles were only captured occasionally at Port St. Lucie and around the Marquesas Keys (Eaton et al. 2008). Juvenile green sea turtles in Florida appear to use nearshore areas year-round for an average of 7 years (Eaton et al. 2008). Along Florida’s Atlantic coast, juvenile green turtles occur in high-wave-energy, nearshore reef environments less than 2 m deep that support an abundance of macroalgae (Holloway-Adkins 2006). Several nearshore habitats have been identified as important, including Mosquito and Indian River lagoons, Port Canaveral, St. Lucie Inlet, and Biscayne Bay (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a). During the winter, the highest concentration of green turtles occurs just north of Cape Canaveral, a known wintering area for juveniles.

Caribbean Sea Large Marine Ecosystem. Adult green sea turtles may be found year-round in small numbers in the U.S. Virgin Islands and Puerto Rico (Boulon and Frazer 1990; Collazo et al. 1992; The State of the World's Sea Turtles Team 2011). Critical habitat was designated for green sea turtles in coastal waters around Culebra Island, Puerto Rico, as shown in Figure 3.5-1. Culebra is an important green sea turtle habitat for juveniles, subadults, and a small population of adults (FR 63 (170): 46693-46701, September 2, 1998). Green sea turtles are most abundant at Culebrita, Mosquito Bay, Puerto Manglar, and Tamarindo Grande, probably due to the presence of dense seagrass beds in those areas (Collazo et al. 1992).

Gulf of Mexico Large Marine Ecosystem. Juveniles use the estuarine and nearshore waters of central Florida throughout the year, including Pensacola Bay, St. Joseph Bay, Charlotte Harbor, Cedar Keys, Homosassa Springs, Crystal River, and Tampa Bay (Renaud et al. 1995). In the northern Gulf of Mexico, green sea turtles prefer the coastal habitats of southern Texas (e.g., lagoons, channels, inlets, bays) where seagrass beds and macroalgae are abundant, including Texas’ Laguna Madre (Renaud et al. 1995). As water temperatures rise from April to June, green sea turtle numbers increase in the continental shelf waters of the Gulf of Mexico Large Marine Ecosystem, off Galveston Bay, and in those waters associated with the continental shelf break northeast of Corpus Christi. Green sea turtles found in these deeper waters are likely adults migrating from resident foraging grounds to distant nesting grounds (Meylan 1995). The sparse sighting records in Louisiana and Texas waters, as well as nesting records on the southern Texas coast, indicate that green turtles are found in the northwestern Gulf of Mexico during spring but in far fewer numbers than in the northeastern Gulf. Suitable nesting beaches are located throughout the Gulf region, from the shores of northern Mexico and southern Texas in the western Gulf of Mexico to southern Florida and the Florida panhandle in the eastern Gulf of Mexico.

3.5.2.4.3 Population and Abundance

The greatest concentration of green turtle nesting within the Study Area occurs in Monroe County, Florida, which includes most of the Florida Keys and the Dry Tortugas (Meylan et al. 1995). An annual average of 8,927 green sea turtles nested in Florida from 2006 to 2010, making this the second largest green sea turtle nesting population in the wider Caribbean (Florida Fish and Wildlife Conservation Commission 2011; Meylan et al. 2006). Records of green sea turtle nestings have also been reported from the Florida panhandle, Georgia, Alabama, South Carolina, North Carolina, and Texas (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a; The State of the World's Sea Turtles Team 2011). A green turtle nested at Cape Henlopen State Park in Delaware in August 2011, which was the first green turtle nesting ever observed north of Virginia (Murray 2011). While nesting abundance has been monitored at these sites for decades, in-water abundance in the Gulf of Mexico or along the Atlantic coast remains unavailable (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a). Adult and juvenile males and females from nesting colonies in the Yucatan Peninsula (Mexico), Aves Island (Venezuela), Galibi Reserve (Suriname), and Isla Trinidade (Brazil) could also occur in the waters of the Study Area.

The Marine Turtle Specialist Group (under the International Union for Conservation of Nature’s Species Survival Commission) conducted a worldwide analysis of the green sea turtle population based on 32 index nesting sites around the world (Marine Turtle Specialist Group 2004). The analysis concluded there has been a 48 to 65 percent decline in the number of females nesting annually over the past 100 to 150 years. NMFS and the U.S. Fish and Wildlife Service (2007a) assessed nesting abundance at 46 sites in all regions inhabited by green sea turtles. Of these 46 sites, six occur in the Western Atlantic Ocean and one (Florida) occurs in the Study Area. About 80 percent of nesting in the Western Atlantic Ocean occurs at Tortuguero, Costa Rica. Generally, nesting trends in the Western Atlantic Ocean are stable to increasing and are increasing in Florida. Although these data appear to present an encouraging global outlook, datasets for fewer than half of these sites (9 of 23) document a time span of longer than 20 years, which limits the strength of the data. A standard timeframe of data that would be necessary to properly assess population trends is three generations, which for the green sea turtle is between 100 and 150 years. Consequently, the impact of changes in juvenile recruitment that occurred four decades ago may not yet be manifested in changes in nesting abundance (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a).

3.5.2.4.4 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). They have a finely serrated jaw that assists with tearing vegetation, and the esophagus is lined with papillae (spiny projections) that trap food before swallowing. 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. Pelagic juveniles smaller than 8–10 in. (20.3–25.4 cm) in length eat worms, young crustaceans, aquatic insects, grasses, and algae (Bjorndal 1997). After settling in coastal juvenile developmental habitat at 8–10 in. (20.3–25.4 cm) in length, they eat mostly mangrove leaves, seagrass and algae (Balazs et al. 1994; Nagaoka et al. 2012). Recent 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; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007a; Parker and Balazs 2008; Russell et al. 2011).

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 and U.S. Fish and Wildlife Service 1991).

3.5.2.4.5 Species-Specific Threats

In addition to the general threats described in Section 3.5.2.3 (General Threats), damage to seagrass beds and declines in seagrass distribution can reduce foraging habitat for green sea turtles (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991; 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 and U.S. Fish and Wildlife Service 1991). Some populations have begun to show resistance to the disease, but it remains an issue for others (Chaloupka et al. 2009). Green sea turtles are also captured and killed in commercial fisheries. Gillnets account for the highest number of green sea turtle mortalities; green sea turtles are also captured in trawls, traps and pots, longlines, and dredges. NMFS estimated that almost 19,000 green sea turtles are captured in shrimp trawl fisheries each year in the Gulf of Mexico, with 514 of those sea turtles dying as a result of their capture. Each year, several hundred green sea turtles are captured in herring, mackerel, squid, butterfish, and monkfish fisheries; pound net, summer flounder, and scup fisheries; Atlantic pelagic longline fisheries; and gillnet fisheries in Pamlico Sound. Although most of these turtles are released alive, these fisheries are expected to kill almost 100 green sea turtles each year (National Marine Fisheries Service 2011b). In the Atlantic, outside of the United States, green sea turtles are captured and killed in fisheries in

Colombia, Grenada, the Lesser Antilles, Nicaragua, St. Vincent, and the Grenadines (Brautigam and Eckert 2006; Grazette et al. 2007). The turtle fishery along the Caribbean coast of Nicaragua alone captures more than 11,000 green sea turtles each year (Brautigam and Eckert 2006).

3.5.2.5 Hawksbill Sea Turtle (*Eretmochelys imbricata*)

3.5.2.5.1 Status and Management

The hawksbill turtle is listed as endangered under the ESA (FR 35 (106): 8491-8498, June 2, 1970). 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 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). Critical habitat was designated for hawksbill terrestrial nesting areas in Puerto Rico in 1982, which includes portions of Mona Island, Culebra Island, Cayo Norte, and Island Culebrita, from the mean high tide line to a point 490 ft. (150 m) from shore (FR 47 (122): 27295-27298, June 24, 1982). Critical marine habitat was designated in 1998 for the coastal waters surrounding Mona and Monito Islands, Puerto Rico from the mean high water line seaward to three nm (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a). These critical habitat areas are shown in Figure 3.5-2. Critical habitat includes (1) coral reefs for food and shelter and (2) nesting beaches. The essential physical and biological features of coral reefs support a large, long-term juvenile hawksbill population, in addition to subadults and adults. The types of sponges that hawksbills prefer are found on the reefs around these islands. Reef ledges and caves also provide resting areas and protection from predators. Nesting beaches on Mona Island support the largest population of nesting hawksbill turtles in the U.S. Caribbean (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a).

3.5.2.5.2 Habitat and Geographic Range

The hawksbill is the most tropical of the world's sea turtles, rarely occurring above 35° N or below 30° S (The State of the World's Sea Turtles Team 2008; Witzell 1983). Hatchlings are believed to occupy open-ocean waters, associating themselves with surface algal mats in the Atlantic Ocean (Parker 1995; Witherington and Hirama 2006; Witzell 1983). Juveniles leave the open-ocean habitat after 3 to 4 years and settle in coastal foraging areas, typically coral reefs but occasionally seagrass beds, algal beds, mangrove bays, and creeks (Mortimer and Donnelly 2008). Juveniles and adults share the same foraging areas, including tropical nearshore waters associated with coral reefs, hard bottoms, or estuaries with mangroves (Musick and 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 295 ft. (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; Shaver and Rubio 2008; Shaver et al. 2005). 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 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). Female hawksbills return to their natal beach every 2 to 3 years to nest at night, every 14 to 16 days during the nesting season. During nesting season in the Caribbean, adult females tend to settle up-current and within 7 km (3.8 nm) of the nesting beach between nesting attempts (Walcott et al. 2012). In the Caribbean Sea and Gulf of Mexico Large Marine Ecosystems, the principal nesting season is from June to November (Hillis 1990). Limited nesting occurs in the Study Area.

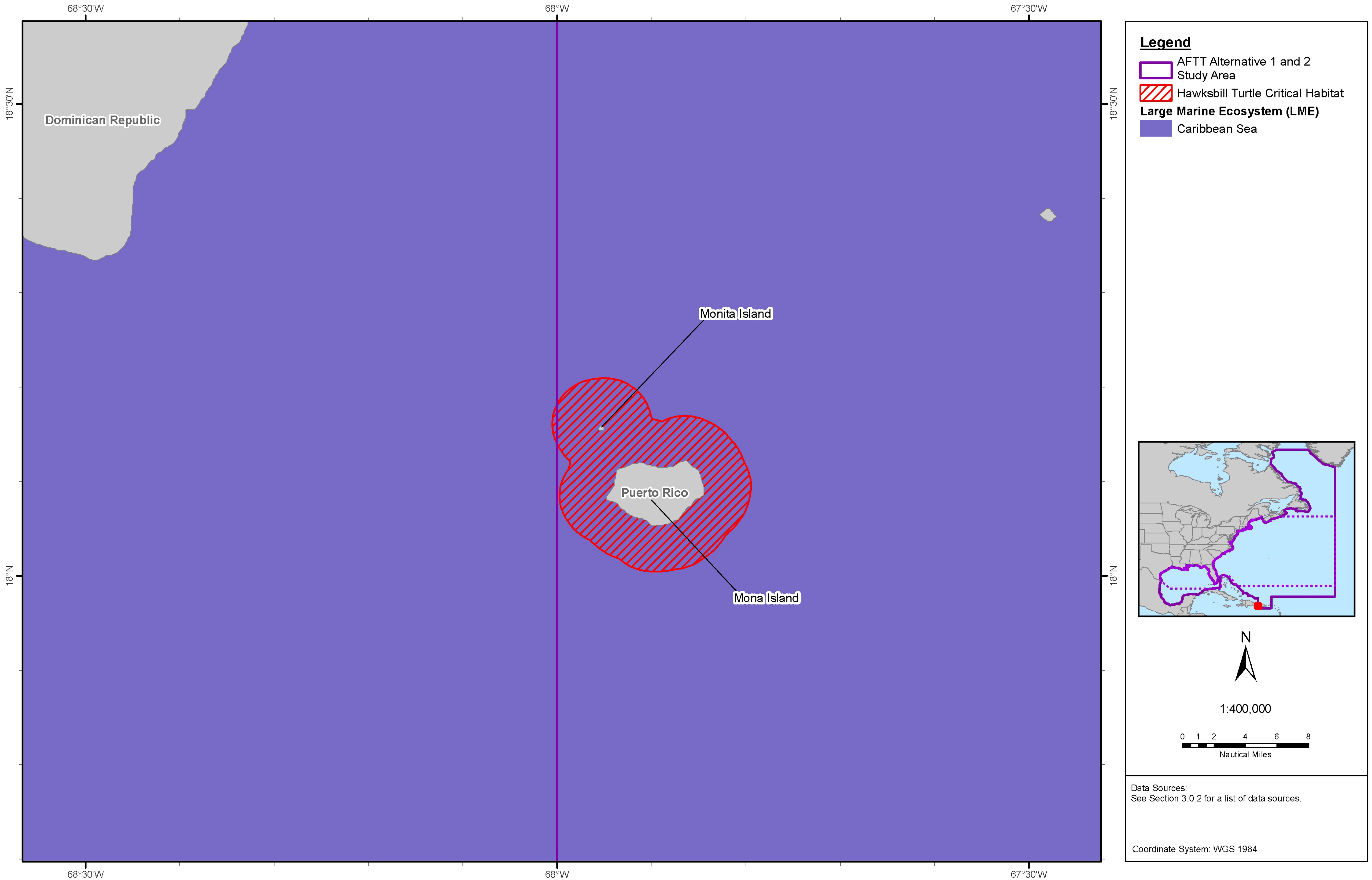

Figure 3.5-2: Critical Habitat Areas for Hawksbill Sea Turtles in the Study Area
AFTT: Atlantic Fleet Training and Testing

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Gulf Stream and North Atlantic Gyre Open Ocean Areas. 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. Despite a lack of information regarding the hawksbill turtle's use of the open ocean in all life stages, they have been reported rarely off of Cape Cod and in North Carolina (The State of the World's Sea Turtles Team 2008; Witzell 1983). Due to these sightings and the relative warmth of the Gulf Stream into the higher latitudes of the North Atlantic, hawksbills are assumed to be present in the North Atlantic Gyre and Gulf Stream Open Ocean Areas.

Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems. Hawksbill turtles occur regularly in the nearshore waters of southern Florida and the Gulf of Mexico (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). In the continental United States, the species is recorded from all the gulf states and along the east coast as far north as Massachusetts. However, sightings north of Florida are rare, and Texas is the only other state where hawksbills are sighted with any regularity (Keinath et al. 1991; Lee and Palmer 1981; Parker 1995; Plotkin 1995).

The greatest hawksbill turtle numbers in the southeastern United States are found in the autumn off southern Florida. There, hawksbills are documented from winter to summer from Palm Beach, Broward, and Dade Counties to the Florida Keys, and to coastal waters just northwest of Tampa Bay, where the northernmost stranding records typically occur (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). Foraging juveniles and adults settle on coral reef and hard bottom habitats off southern Florida throughout the year (Musick and Limpus 1997). Hawksbill turtle sightings in waters off the Florida panhandle, Alabama, Mississippi, Louisiana, and Texas (Rabalais and Rabalais 1980; Rester and Condrey 1996; Witzell 1983), though rare, are likely of early juveniles born on nesting beaches in Mexico that have drifted north with the dominant currents (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1993).

Caribbean Sea Large Marine Ecosystem. Hawksbills occur year-round in the nearshore waters of the Caribbean Islands. They nest throughout the Caribbean and along Columbia and Venezuela in Central America (Dow et al. 2007). Major nesting areas in the United States are on Mona Island in Puerto Rico and on Buck Island Reef National Monument off St. Croix in the U.S. Virgin Islands (Hillis 1990; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b).

3.5.2.5.3 Population and Abundance

The 2007 five-year review (2007b) assessed nesting abundance and nesting trends in all regions inhabited by hawksbill turtles. An estimated 21,212–28,138 turtles nest each year in the Atlantic, Indian, and Pacific oceans; of these, 3,072 to 5,603 occur in the Atlantic Ocean alone. Historical population trends showed overall declines for the 20- to 100-year period of evaluation. An analysis of 25 index sites around the world indicated that hawksbill nesting has declined globally by at least 80 percent over the last three hawksbill generations (105 years in the Atlantic Ocean and 135 years in the Indo-Pacific Ocean) (Meylan and Donnelly 1999). In the Study Area, population trends vary within the Caribbean, and trends are not known for many locations (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). For example, populations in Jumby Bay, Antigua, are increasing but are decreasing in Antigua outside of Jumby Bay. On Mona Island in Puerto Rico, 199 to 332 female hawksbills nest annually, and trends are increasing. On Buck Island Reef National Monument off St. Croix in the U.S. Virgin Islands, an estimated 56 females nest annually, and trends are increasing (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b). A large rookery of 534 to 891 female hawksbills nest on the Yucatán Peninsula (Campeche, Yucatán, and Quintana Roo) each year, and trends there are increasing (Abreu-Grobois et al. 2005).

3.5.2.5.4 Predator and Prey Interactions

Hawksbill turtles fill a unique ecological niche in marine and coastal ecosystems, supporting the natural functions of coral reefs by keeping sponge populations in check (Hill 1998; Leon and Bjorndal 2002). Feeding on sponges helps to control populations of sponges that may otherwise compete for space with reef-building corals (Hill 1998; Leon and Bjorndal 2002). Post-hatchling hawksbills feed on floating *Sargassum* in the open ocean (Plotkin and Amos 1998). 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). In the Caribbean, as hawksbills grow, they begin feeding exclusively on only a few types of sponges (Hill 1998; Leon and Bjorndal 2002). Their beak-like mouth allows the hawksbill turtle to reach into holes and crevices of coral reefs to find sponges as well as other invertebrates. As with other sea turtle species, the hawksbill's esophagus is lined with papillae (spiny projections) that trap food before swallowing.

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 (Witzell 1983).

3.5.2.5.5 Species-Specific Threats

In addition to the general threats described in Section 3.5.2.3 (General Threats), the greatest threat to hawksbills is harvest for commercial and subsistence use. 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 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b).

Until relatively recently, tens of thousands of hawksbills were captured and killed each year to meet demand for jewelry, ornamentation, and whole stuffed turtles (Milliken and Tokunaga 1987). Because the hawksbill shell is prized for jewelry and other crafts, the trade of this species and the products it produces is prohibited under the Convention on International Trade in Endangered Species of Wild Flora and Fauna. Despite this protection, illegal trade remains a threat to the species (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007b).

The second most significant threat to hawksbill sea turtles is loss of nesting habitat caused by the expansion of resident 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 and 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.

Bycatch in commercial fisheries is also an issue for hawksbill sea turtles. Along the Atlantic coast of the United States, NMFS estimates that about 650 hawksbill sea turtles are captured in shrimp trawl fisheries each year in the Gulf of Mexico, with most sea turtles dying as a result of their capture. In addition, about 35 hawksbills are captured and potentially killed each year in Atlantic pelagic longline fisheries (National Marine Fisheries Service 2011b). 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 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1993).

3.5.2.6 Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)

3.5.2.6.1 Status and Management

The Kemp's ridley sea turtle is listed as a single population and is classified as endangered under the ESA (FR 35 (233): 18319-18322, December 2, 1970). The National Marine Fisheries Service and the U.S. Fish and Wildlife Service are currently reviewing a petition to designate critical habitat for Kemp's ridley sea turtles for nesting beaches along the Texas coast and marine habitats in the Gulf of Mexico and Atlantic Ocean (WildEarth Guardians 2010); however, there is no critical habitat currently designated for this species. The Kemp's ridley turtle has received protection in Mexico since the 1960s and in the United States since 1970. Harvesting of eggs and turtles, and death from trawl fisheries in the Gulf of Mexico, resulted in a worldwide population decline, from tens of thousands of nesting females in the late 1940s to about 300 nesting females in 1985 (Turtle Expert Working Group 2000). The dramatic decline in this population led to intensive management efforts by both Mexican and U.S. environmental agencies. These efforts included protecting nesting beaches from human and animal predators, hatchery programs, and fishing regulations, particularly the requirement of the shrimp industry to use turtle excluder devices.

3.5.2.6.2 Habitat and Geographic Range

Habitats frequently used by Kemp's ridley sea turtles in U.S. waters are warm-temperate to subtropical sounds, bays, estuaries, tidal passes, shipping channels, and beachfront waters, where their preferred food, the blue crab, is abundant (Lutcavage and Musick 1985; Seney and Musick 2005). Prolonged exposure to water at 50°F (10°C) or lower can cause Kemp's ridleys to become cold-stunned (sluggish behavior and reduced activity due to exposure to cold water) (Burke et al. 1991). Adult female Kemp's ridley sea turtles take part in mass synchronized nesting emergences known as "arribadas" on only a few nesting beaches; this nesting strategy is unique to *Lepidochelys* spp. Kemp's ridley turtles may also be solitary nesters, but this is less common and generally occurs outside of the main nesting areas in Mexico. In recent years, nesting females have been seen as far north as Georgia and North Carolina, and in 2012, a single nest was laid in Virginia (Back Bay Restoration Foundation 2012). At this time it cannot be determined if these nests represent a permanent range expansion/shift, or if they simply represent seasonal variation or eccentric individuals. Also unlike other species, Kemp's ridley turtles nest primarily during daylight hours (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2011). The nesting season in the Study Area occurs from April through July.

Evidence suggests that post-hatchling and small juvenile Kemp's ridley sea turtles, similar to loggerhead and green sea turtles of the same region, forage and develop in floating *Sargassum* habitats of the North Atlantic Ocean. Juveniles migrate to habitats along the U.S. Atlantic continental shelf from Florida to New England (Morreale and Standora 1998; Peña 2006) at around 2 years of age. Migrating juvenile Kemp's ridleys travel along coastal corridors generally shallower than 164 ft. (50 m) in bottom depth (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2011). Suitable developmental habitats are seagrass beds and mud bottoms in waters of less than 33 ft. (10 m) bottom depth and with sea surface temperatures between 72°F and 90°F (22°C and 32°C) (Coyne et al. 2000).

Gulf Stream and North Atlantic Gyre Open Ocean Areas. Recent analysis of sightings and strandings from the eastern Atlantic Ocean may indicate that as the population increases, the range of Kemp's ridley sea turtles may be expanding into the eastern Atlantic Ocean and Mediterranean Sea (Witt et al. 2007).

Northeast U.S. Continental Shelf Large Marine Ecosystem. In the spring, Kemp's ridleys in south Florida begin to migrate northward. With each passing month, the waters to the north become warmer and turtles migrate ever farther north until some appear off Long Island Sound and even Nova Scotia in late summer (Bleakney 1955). In the winter, the migration is reversed as turtles move southward in response to local water temperatures; the turtles in the northernmost areas begin their southward movement earliest, joining up with turtles to the south that begin their migration weeks or months later until each reaches its chosen overwintering site. By early November, turtles from New York and New Jersey merge with turtles from the Chesapeake Bay (Byles 1988; Keinath 1993; Lutcavage and Musick 1985; Renaud 1995) and North Carolina inshore waters (Epperly et al. 1995a), where large clusters of migrating turtles have been reported during winter (Epperly et al. 1995b; Musick et al. 1994).

Southeast U.S. Continental Shelf Large Marine Ecosystem. Satellite telemetry data suggest that turtles migrate south in October and November within the Southeast U.S. Continental Shelf Large Marine Ecosystem—from Georgia and northern Florida to the waters south of Cape Canaveral—and return to their summer foraging grounds in March and April. Therefore, higher densities of Kemp's ridleys in Florida are likely found in winter. The offshore waters south of Cape Canaveral are identified as an important overwintering area for turtles foraging in Atlantic coastal waters (Henwood and Ogren 1987; Schmid 1995). Waters off central North Carolina, which are relatively warm because of the nearby Gulf Stream, are a potentially important overwintering area (Morreale and Standora 1998).

Gulf of Mexico Large Marine Ecosystem. The Kemp's ridley occurs year-round in the coastal waters of the Gulf of Mexico Large Marine Ecosystem from the Yucatán peninsula to south Florida (Lazell 1980; Morreale et al. 1992). The entire population nests in the Gulf of Mexico, along a stretch of beaches from southern Texas to the Yucatán peninsula. The primary nesting beach for Kemp's ridley turtles is near Rancho Nuevo in Tamaulipas, Mexico, with a smaller nesting population in Veracruz, Mexico. Padre Island National Seashore near Galveston, Texas, supports the largest U.S. nesting aggregation, hosting between 100 and 200 nests annually (Shaver and Caillouet Jr. 1998). Low nesting levels have also been reported elsewhere in Texas, and along the coasts of Alabama and Florida, typically with fewer than 10 nest per year in each area (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2011). Key foraging sites on the west coast of Florida include Charlotte Harbor and Gullivan Bay (Witzell and Schmid 2005).

Post-hatchlings in the Gulf of Mexico appear to transition into the nearshore waters along the northern and eastern shorelines of the Gulf. This transition, as well as post-settlement migration, seems to be seasonal (Renaud and Williams 2005). During spring and summer, juvenile Kemp's ridleys occur in the shallow coastal waters of the northern Gulf of Mexico from south Texas to north Florida. In the fall, most Kemp's ridleys migrate to deeper or more southern warmer waters and remain there through the winter (Schmid 1998). Key foraging sites in the northern Gulf of Mexico Large Marine Ecosystem include Sabine Pass, Texas; Caillou Bay and Calcasieu Pass, Louisiana (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2011); Big Gulley, Alabama; and Apalachicola, Apalachee, Deadman, and Waccasassa Bays, Florida (Schmid et al. 2002).

Satellite tagging studies have shed light on seasonal migration patterns of juvenile turtles in Waccasassa Bay. These turtles migrate in November from the cold shallow waters of Waccasassa Bay either to deeper waters offshore or as far south as Sanibel Island, 185 miles (mi.) (300 kilometers [km]) from their summer foraging grounds. All tracked turtles eventually return to Waccasassa Bay by late March (Renaud and Williams 2005). Recaptured tagged turtles indicate some return to the same summer foraging areas in subsequent years (Schmid 1998), while others occupy relatively confined foraging areas (1.5–18.5 square miles [$mi.^2$] [4–48 square kilometers {km^2}]). These studies reveal that both the nearshore foraging grounds and offshore overwintering areas in the Gulf of Mexico are important to the conservation and recovery of the species (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2011).

Important year-round developmental habitats in the northern Gulf of Mexico include the western coast of Florida (particularly the Cedar Keys area), the eastern coast of Alabama, and the mouth of the Mississippi River (Lazell 1980; Lutcavage and Musick 1985; Marquez-M. 1994; Márquez-M. 1990; National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992b; Schmid et al. 2002; Weber 1995). Coastal waters off western Louisiana and eastern Texas also provide adequate habitats for bottom feeding.

As adults, many turtles remain in the Gulf of Mexico Large Marine Ecosystem, with only occasional occurrence in the Atlantic Ocean (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2011). While the understanding of adult males' distribution and habitat usage is limited, satellite telemetry of males caught near Padre Island, Texas, indicates that they do not migrate, remaining year-round in nearshore waters of less than 165 ft. (less than 50 m) (Shaver et al. 2005). Many of the post-nesting females from Rancho Nuevo migrate north to areas offshore of Texas and Louisiana (Marquez-M. 1994). Farther south, some post-nesting females migrate from Rancho Nuevo to the northern and western Yucatán Peninsula in the Southern Gulf of Mexico, which contains important seasonal foraging sites for adult females—specifically the Bay of Campeche (Marquez-M. 1994; Márquez-M. 1990; Pritchard and Marquez 1973).

3.5.2.6.3 Population and Abundance

Based on the number of nests monitored between 2005 and 2009, an estimated 5,500 females nest each season in the Gulf of Mexico (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2011). Given the current population growth rate, the population could increase to 10,000 nesting females by 2015 (Heppell et al. 2005). The main nesting beach of Kemp's ridley sea turtles is at Rancho Nuevo, Mexico. Since the mid-1980s, the number of nests observed at Rancho Nuevo and nearby beaches increased 14 to 16 percent per year and is expected to continue to grow 12 to 16 percent per year, provided that nest protection and other management measures continue (Heppell et al. 2005). More than 20,000 nests were recorded in 2009 at Rancho Nuevo and adjacent camps (Shaver and Caillouet Jr. 1998). The same year, a record 127 nests were recorded in Texas, 73 of which were documented at Padre Island National Seashore (National Park Service 2011).

3.5.2.6.4 Predator and Prey Interactions

Kemp's ridley sea turtles feed primarily on crabs but are also known to prey on molluscs, shrimp, fish, jellyfish, and plant material (Frick et al. 1999; Marquez-M. 1994). Blue crabs and spider crabs are important prey species for the Kemp's ridley (Keinath et al. 1987; Lutcavage and Musick 1985; Seney and Musick 2005). They may also feed on shrimp fishery bycatch (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1993). As with other sea turtle species, the Kemp's ridley esophagus is lined with papillae (spiny projections) that trap food before swallowing.

Major predators of Kemp's ridley sea turtle eggs and hatchlings on nesting beaches include raccoons, dogs, pigs, skunks, badgers, and fire ants. Predatory fishes such as jackfish and redfish may feed on hatchlings at sea. Sharks are the primary predator of juvenile and adult Kemp's ridley sea turtles (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2011).

3.5.2.6.5 Species-Specific Threats

In addition to the general threats described in Section 3.5.2.3 (General Threats), oil and gas exploration and development in the Gulf of Mexico are a particular threat to Kemp's ridley sea turtles because most of the population occurs there (Shaver and Rubio 2008; Shaver et al. 2005). Kemp's ridley sea turtles periodically strand on beaches in Mexico covered in crude oil, and most of the turtles found injured and dead following the *Deepwater Horizon* oil spill were Kemp's ridley sea turtles (National Marine Fisheries Service 2011a; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2011). Shrimp trawling in the southeastern U.S. Atlantic and Gulf of Mexico was once a significant threat to Kemp's ridleys; however, the use of turtle excluder devices and general decline of shrimp fishing in recent years have greatly reduced mortality levels (Caillouet Jr. et al. 2008; Nance et al. 2012). Vehicle activity on sea turtle nesting beaches can also disrupt the nesting process, crush nests, and create ruts and ridges in the sand that pose obstacles to turtles (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2011). Beach vehicular driving is permitted on most beaches in Texas, where adult turtles and hatchlings have been crushed by passing vehicles, as well as on some beaches in Mexico.

3.5.2.7 Loggerhead Sea Turtle (*Caretta caretta*)

3.5.2.7.1 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 U.S. Fish and Wildlife Service listed five of these distinct population segments as endangered and kept four as threatened under the ESA, effective as of 24 October 2011 (FR 76 (184): 58868-58952, September 22, 2011). 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. The Northwest Atlantic Ocean distinct population segment is the only one that occurs entirely within the Study Area, with geographic boundaries between latitude 60° N and the equator, and stretching to longitude 40° W. However, loggerheads from other distinct population segments may occur within the Study Area. This population is likely to decline in the foreseeable future, primarily as a result of fishery bycatch (FR 69 (128): 40734-40758, July 6, 2004).

At the time of listing loggerhead sea turtle distinct population segments, the U.S. Fish and Wildlife Service and NMFS determined that they lacked the comprehensive data and information necessary to identify and propose critical habitat, and stated that critical habitat would be proposed in a separate rulemaking (FR 76 (184): 58868-58952, September 22, 2011).

On 25 March 2013, the U.S. Fish and Wildlife Service proposed to designate 739.3 mi. (1,189.9 km) of loggerhead sea turtle nesting beaches as critical habitat for the Northwest Atlantic Ocean Distinct Population Segment in coastal counties in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. This accounts for 48 percent of an estimated 1,531 mi. (2,464 km) of coastal beach shoreline, and approximately 84 percent of the documented numbers of nests within these six states (FR 78 (57): 1800-18082, March 25, 2013). None of this proposed critical habitat includes DoD areas of Marine Corps Base Camp Lejeune (Onslow Beach), Cape Canaveral Air Force Station, Patrick Air Force Base, and Eglin Air Force Base, which are exempt from critical habitat designation because their Integrated Natural Resources Management Plans incorporate measures that provide a benefit for the conservation of the loggerhead sea turtle. There fore, no U.S. Fish and Wildlife Service designated critical habitat for loggerhead sea turtles occurs in the Study Area.

Critical habitat for loggerhead turtles was not designated in the Study Area when the Navy initiated ESA consultation with the NMFS. On 18 July 2013 NMFS issued a proposed rule for the designation of loggerhead turtle critical habitat. Prior to the release of the proposed rule, NMFS provided the Navy with information on areas where loggerhead turtle critical habitat would be proposed. NMFS also provided to the Navy the primary biological features and primary constituent elements being considered in the proposed designation. Discussions between the Navy and NMFS indicated that there is overlap between the areas being evaluated for critical habitat and Navy activities. However, both the Navy and NMFS determined that these Navy activities, as currently conducted, are not the types of activities that may affect or adversely modify critical habitat for the loggerhead sea turtle or its primary biological features and primary constituent elements. The Navy will continue to monitor the designation of loggerhead critical habitat and revisit this determination if new information arises or areas proposed for designation are modified.

3.5.2.7.2 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 next to warm currents (Dodd 1988), preferring beaches facing the ocean or along narrow bays (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b). Nesting in the Study Area occurs from April through September, with a peak in June and July (Dodd 1988; Weishampel et al. 2006; Williams-Walls et al. 1983). Large nesting colonies exist in Florida, with more limited nesting along the gulf coast and north through Virginia. At emergence, hatchlings swim to offshore currents and remain in the open ocean, often associating with floating mats of *Sargassum* (Carr 1986, 1987; Witherington and Hirama 2006). Migration between oceanic and nearshore habitats occurs during the juvenile stage as turtles move seasonally from open-ocean current systems to nearshore foraging areas (Bolten 2003; Mansfield 2006). Once adults, loggerheads continue to migrate seasonally from feeding areas to mating and, for females, nesting areas (Bolten 2003). After reaching sexual maturity, adult turtles settle in nearshore foraging habitats (Godley et al. 2003; Musick and Limpus 1997).

Gulf Stream and North Atlantic Gyre Open Ocean Areas. Post-hatchling Northwest Atlantic loggerhead sea turtles migrate offshore into *Sargassum* habitats in northeast Atlantic open-ocean waters. Their open-ocean range reaches beyond the eastern boundary of the Study Area to waters surrounding the Azores and Madeira and the Mediterranean Sea (Bowen et al. 2004; Conant et al. 2009). Genetic evidence shows that open-ocean loggerhead sea turtles found near the Azores are often derived from the nesting populations in the southeastern United States (Bolten et al. 1994; Bolten et al. 1998). After reaching a length of 16 in. (40 cm) (Carr 1987), early juvenile loggerheads make a transoceanic crossing, swimming back to nearshore feeding grounds near their beach of origin in the western Atlantic Ocean (Bowen et al. 2004; Musick and Limpus 1997). Based on growth rate estimates, the duration of the open-ocean juvenile stage for North Atlantic loggerhead sea turtles is estimated to be 8.2 years (Bjorndal et al. 2000).

Juvenile loggerhead sea turtles inhabit offshore waters in the North Atlantic Ocean, where they are often associated with natural and artificial reefs (Fritts et al. 1983). These offshore habitats provide juveniles with an abundance of prey and sheltered locations where they can rest (Rosman et al. 1987). Subadult and adult loggerhead turtles tend to inhabit deeper offshore feeding areas along the western Atlantic coast, from mid-Florida to New Jersey (Hopkins-Murphy et al. 2003; Roberts et al. 2005).

Juveniles also use the strong current of the North Atlantic Gyre to move from developmental nursery habitats to later developmental habitats, and to and from adult foraging, nesting, and breeding habitats (Bolten et al. 1998; Musick and Limpus 1997).

Newfoundland-Labrador Shelf and Scotian Shelf Large Marine Ecosystems. Loggerheads are generally observed in the northern extent of their range during the summer, in shallow water habitats with large expanses of open-ocean access. This summer distribution likely extends into the Gulf of Maine and waters over the Scotian Shelf, with some individuals venturing as far north as Newfoundland (Bolten et al. 1992).

Northeast U.S. Continental Shelf Large Marine Ecosystem. Shoop and Kenney (1992) estimated that a minimum of 8,000–11,000 loggerheads are present in the Northeast U.S. Continental Shelf Large Marine Ecosystem waters each summer, with the highest summer occurrence in waters over the mid-continental shelf, roughly from Delaware Bay to Hudson Canyon. Small bottom-feeding juveniles in Delaware Bay are the predominant loggerhead size class found along the northeast and mid-Atlantic U.S. coast (Turtle Expert Working Group 1998), while adults inhabit the entire continental shelf area (Hopkins-Murphy et al. 2003). Juveniles are frequently observed in developmental habitats, including coastal inlets, sounds, bays, estuaries, and lagoons with depths less than 100 m (Hopkins-Murphy et al. 2003; Turtle Expert Working Group 1998). Long Island Sound, Cape Cod Bay, and Chesapeake Bay are the most frequently used juvenile developmental habitats along the Northeast U.S. Continental Shelf Large Marine Ecosystem (Burke et al. 1991; Mansfield 2006; Prescott 2000; University of Delaware Sea Grant 2000). Core Sound and Pamlico Sound, North Carolina, on the border between the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems, represent important developmental habitat for juvenile loggerheads (Epperly et al. 1995a). Although these habitats are also used by greens and Kemp's ridleys, loggerheads are the most abundant sea turtle species within the summer developmental habitats of North Carolina (Epperly et al. 1995c).

Southeast U.S. Continental Shelf Large Marine Ecosystem. As later juveniles and adults, loggerhead sea turtles most often occur on the continental shelf and along the shelf break of the U.S. Atlantic and gulf coasts, as well as in coastal estuaries and bays (Cetacean and Turtle Assessment Program and University of Rhode Island 1982; Shoop and Kenney 1992). In a sampling study from 2004 to 2007, juveniles were the most abundant age group among loggerheads found in the Charleston, South Carolina, shipping channel between May and August (Arendt et al. 2012). Immature loggerhead sea turtles may occupy coastal feeding grounds for 20 years before their first reproductive migration (Bjorndal et al. 2001). Hawkes et al. (2006) found that adult females forage predominantly in shallow coastal waters along the U.S. Atlantic coast less than 328 ft. (100 m) deep, likely exploiting bottom-dwelling prey.

Coles and Musick (2000) identified preferred sea surface water temperatures to be between 56°F and 82°F (13.3°C and 28°C) for loggerhead turtles off North Carolina. Loggerheads become lethargic at about 56°F (13°C), becoming cold-stunned (sluggish behavior and reduced activity due to exposure to cold water) in water around 50°F (10°C) (Mrosovsky 1980). As water temperatures drop from October to December, most loggerheads emigrate from their summer developmental habitats and eventually return to warmer waters south of Cape Hatteras, where they spend the winter (Morreale and Standora 1998). Cold-stunned loggerheads are often found between December and February offshore of Cape Lookout, North Carolina (Schwartz 1989). The nesting population of the Northwest Atlantic Ocean loggerhead sea turtle distinct population segment is concentrated along the U.S. east coast and Gulf of Mexico from southern Virginia to Alabama (Conant et al. 2009). The southern Florida nesting population produces from 49,000 to 83,000 nests per year. The greatest proportion of that nesting occurs on the

Florida Atlantic coast, below latitude 29° N (Ehrhart et al. 2003). The Navy conducted surveys to assess loggerhead abundance within its ranges as part of Atlantic Fleet Active Sonar Training monitoring requirements and to collect baseline data in support of the Undersea Warfare Training Range Environmental Impact Statement (EIS), which provided the following site-specific data. Monthly aerial surveys conducted from January to August 2009 sighted 193 loggerhead turtles off the coast of Jacksonville, Florida, while line-transect surveys off North Carolina during the same period sighted 41 loggerhead sea turtles (U.S. Department of the Navy 2009). Aerial observations in Onslow Bay from 2 August 2009 through 1 August 2010 sighted 495 loggerhead sea turtles, while vessel surveys during the same period sighted 47 loggerhead sea turtles (U.S. Department of the Navy 2010). Aerial surveys conducted between 2 August 2009 and 1 August 2010 off Jacksonville, Florida, sighted 716 loggerhead sea turtles, while vessel surveys during the same period sighted 47 loggerhead sea turtles (U.S. Department of the Navy 2010). The prevalence for the high number of loggerhead sea turtle sightings is partly because of the location of the surveys, which correlates with their primary habitat, and also because loggerheads are one of the more easily recognizable sea turtle species (other than the leatherback) due to their size and distinctive head.

Caribbean Sea Large Marine Ecosystem. Nesting beaches for the Northwest Atlantic Ocean loggerhead sea turtle distinct population segment are found in the eastern Bahamas, southwestern Cuba, and the eastern Caribbean Islands. After leaving open-ocean habitats, some juveniles migrate to the Bahamas and Cuba (Conant et al. 2009). Juveniles may also use small-scale surface currents for transportation, migrating counter to North Atlantic prevailing currents (Conant et al. 2009).

Gulf of Mexico Large Marine Ecosystem. Loggerhead sea turtles can be found during all seasons in both continental shelf and slope waters of the Gulf of Mexico, with a much higher abundance in the northeastern Gulf than in the northwestern Gulf (Davis et al. 2000; Fritts et al. 1983). Based on aerial survey data, an estimated 12 percent of all western North Atlantic Ocean loggerhead sea turtles reside in the eastern Gulf of Mexico, and the vast majority occur in western Florida waters (Davis et al. 2000; Turtle Expert Working Group 1998). Nesting is infrequent in this region, and juvenile loggerheads appear to primarily use the developmental habitats found in the northwestern Gulf (Bolten 2003; Bowen et al. 1995; Musick and Limpus 1997; Pitman 1990; Zug et al. 1995). Coastal juveniles and adult loggerhead sea turtles may be attached to high prey concentrations around offshore oil platforms in the Gulf (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009) but are more often documented in association with natural and artificial reefs off Florida (Davis et al. 2000; Rosman et al. 1987). The occurrence of loggerhead sea turtles during winter is likely concentrated in the northeastern Gulf, in Alabama and Florida panhandle shelf waters, and in the deeper off-shelf waters from Texas to Florida, although not as abundantly as in shelf waters. The high number of strandings along the central and southern Florida coasts, as well as the numerous sighting records from the Florida Keys, indicates that loggerheads are likely just as common in waters off southern Florida as they are off Alabama and the Florida panhandle during winter.

3.5.2.7.3 Population and Abundance

There are at least five demographically independent loggerhead sea turtle nesting groups or subpopulations of the Northwest Atlantic Ocean: (1) the Northern Recovery Unit, from the Florida-Georgia border to southern Virginia; (2) the Peninsular Florida Recovery Unit, along Florida's Atlantic coast to Key West; (3) the Dry Tortugas Recovery Unit, encompassing all islands west of Key West; (4) the Northern Gulf of Mexico Recovery Unit, from the Florida panhandle through Texas; and (5) the Greater Caribbean Recovery Unit, from Mexico through French Guiana, the Bahamas, and the Lesser and Greater Antilles (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009). Annual nesting totals of loggerheads on the U.S. Atlantic and gulf coasts fluctuated between 47,000 and 90,000 nests, with an average of 70,880 nests from 1989 to 2007 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

The South Florida nesting subpopulation is the largest known loggerhead sea turtle nesting assemblage in the Atlantic Ocean, with an average of 64,513 nests from 1989 to 2007, and is the second largest in the world (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009). Between 1989 and 1998, loggerhead nest counts on Florida beaches increased. However, since 1998, nest counts have declined by 41 percent with a net decrease over the 18-year period (Witherington et al. 2009). The Northern Recovery Unit is the second largest of these five units, with an average of 5,215 nests laid per year. This unit has experienced a long-term decline since at least 1983. The Northern Gulf of Mexico Recovery Unit subpopulation appears to be the third largest of the U.S. nesting subpopulations, with an average of 906 nests from 1995 to 2007 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009). This subpopulation is also in decline. Data for the Greater Caribbean Recovery Unit are not sufficiently complete to determine the overall size of this subpopulation, nor are trends available at this time.

3.5.2.7.4 Predator and Prey Interactions

The diet of a loggerhead sea turtle varies by age class (Godley et al. 1998). The gut contents of post-hatchlings found in masses of *Sargassum* contained parts of *Sargassum*, zooplankton, jellyfish, larval shrimp and crabs, and gastropods (Carr and Meylan 1980; Richardson and McGillivary 1991; Witherington 1994). Juvenile and subadult loggerhead turtles are omnivorous, foraging on crabs, molluscs, jellyfish, and vegetation captured at or near the surface (Dodd 1988). Adult loggerhead sea turtles are generalized carnivores that forage on nearshore bottom-dwelling invertebrates (molluscs, crustaceans, and anemones) and sometimes fish (Dodd 1988). During migration through the open sea, they eat jellyfish, sea slugs, floating molluscs, floating egg clusters, fish, and squid. As with other sea turtle species, the loggerhead’s esophagus is lined with papillae (spiny projections) that trap food before swallowing.

Common predators of eggs and hatchlings on nesting beaches are ghost crabs, raccoons, feral pigs, foxes, coyotes, armadillos, and fire ants (Dodd 1988). 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; Simpfendorfer et al. 2001).

3.5.2.7.5 Species-Specific Threats

In addition to the general threats described in Section 3.5.2.3 (General Threats), 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). Shrimp trawl fisheries account for the highest number of loggerhead sea turtle fishery mortalities; however, loggerheads are also captured and killed in trawls, traps and pots, longlines, and dredges. Along the Atlantic coast of the United States, NMFS estimated that almost 163,000 loggerhead sea turtles are captured in shrimp trawl fisheries each year in the Gulf of Mexico, with 3,948 of those sea turtles dying as a result of their capture. Each year, several hundred loggerhead sea turtles are also captured in herring, mackerel, squid, butterfish, and monkfish fisheries; pound net fisheries, summer flounder and scup fisheries; Atlantic pelagic longline fisheries; and gillnet fisheries in Pamlico Sound. Combined, these fisheries capture about 2,000 loggerhead sea turtles each year. Although most are released alive, about 700 turtles are killed annually (National Marine Fisheries Service 2011b).

Vehicle use on sea turtle nesting beaches is also an issue for loggerheads. Vehicles are allowed on some beaches in Florida, Georgia, North Carolina, Virginia, and Texas. Vehicles can run over and kill hatchlings or nesting adult turtles on the beach, disrupt the nesting process, create ruts in the sand that impede turtle movement, and crush nests (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2009).

3.5.2.8 Leatherback Sea Turtle (*Dermochelys coriacea*)

3.5.2.8.1 Status and Management

The leatherback sea turtle is listed as a single population and is classified as endangered under the ESA (FR 35 (106): 8491-8498, June 2, 1970). Although the U.S. Fish and Wildlife Service 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 and U.S. Fish and Wildlife Service 2007c). 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. Based on this research, the Turtle Expert Working Group (under the National Oceanic and Atmospheric Administration's Southeast Fisheries Science Center) (Turtle Expert Working Group 2007) recommends that seven Atlantic Ocean stocks be considered: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guyana Shield/Trinidad, West Africa, South Africa, and Brazil. Leatherback sea turtles from all nesting stocks have the potential to be within the off-shore portions of the Study Area, but only two of these—the Florida stock and the Northern Caribbean stock—nest on beaches in the jurisdiction of the United States.

One of the most globally important stocks of leatherback turtles, the Southern Caribbean Stock, nests in French Guiana, Guyana, Suriname, and Trinidad but migrates and forages throughout the North Atlantic. The Western Caribbean stock of the Central American coast also migrates through the Study Area en route to North Atlantic foraging grounds. Nesting populations in southern Florida, Culebra, Puerto Rico, and the U.S. Virgin Islands are believed to be increasing due to heightened protection and monitoring of the nesting habitat over the past 30 years (Turtle Expert Working Group 2007). Critical habitat was designated for the leatherback's terrestrial environment on St. Croix in 1978; this area is a strip of land 0.2 mi. (0.3 km) wide (mean high tide inland) at Sandy Point Beach (FR 43 (187): 43688-43689, September 26, 1978). The essential physical and biological feature of this critical habitat is its function as an important nesting beach (FR 43 (187): 43688-43689, September 26, 1978). In 1979, critical habitat was designated for the waters next to Sandy Point, St. Croix, up to and including the waters from the 100-fathom curve shoreward to the mean high tide line, as shown in Figure 3.5-3 (FR 44 (58): 17710-17712, March 23, 1979). The essential physical and biological feature of this critical habitat is its function as an important courtship and mating area adjacent to the nesting beach (FR 44 (58): 17710-17712, March 23, 1979).

NMFS and U.S. Fish and Wildlife Service were petitioned on 2 November 2010 by the Sierra Club to revise the critical habitat designated for Atlantic leatherbacks to include the coastline and offshore waters of the Northeast Ecological Corridor of Puerto Rico, extending at least to the 100 fathom contour, or 9 nm offshore, whichever is further (The Sierra Club 2010). On 5 May 2011, NMFS announced their 90-day finding on the petition, which stated that the petition presented substantial scientific information indicating that the requested revision may be warranted (FR 76 (87): 25660-25662, May 5, 2011). The U.S. Fish and Wildlife Service issued a similar 90-day finding and 12-month determination on the petition on 4 August 2011, which stated their intent to assess critical habitat during the future planned status review for the leatherback sea turtle (FR 76 (150): 47133-47139, August 4, 2011). In January 2012, NMFS designated critical habitat for the leatherback in the Pacific Ocean (outside of the Study Area). The designation includes 16,910 $mi.^2$ (43,798 km^2) stretching along the California coast from Point Arena to Point Arguello east of the 3,000 m depth contour; and 25,004 $mi.^2$ (64,760 km^2) stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 m depth contour (FR 77 (17): 4170-4201, January 26, 2012).

3.5.2.8.2 Habitat and Geographic Range

Limited information is available on the habitats used by post-hatchling and early juvenile leatherback sea turtles because these age classes are entirely oceanic (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992a). These life stages are restricted to waters warmer than 79°F (26°C); consequently, much time is spent in the tropics (Eckert 2002). They are not considered to associate with *Sargassum* or other flotsam, as is the case for all other sea turtle species (Horrocks 1987; Johnson 1989). Upwelling areas, such as equatorial convergence zones, serve as nursery grounds for post-hatchling and early juvenile leatherback sea turtles because these areas provide a high biomass of prey (Musick and Limpus 1997).

Late juvenile and adult leatherback sea turtles are known to range from mid-ocean to the continental shelf and nearshore waters (Grant and Ferrell 1993; Schroeder and Thompson 1987; Shoop and Kenney 1992). Juvenile and adult foraging habitats include both coastal and offshore feeding areas in temperate waters and offshore feeding areas in tropical waters (Frazier 2001). The movements of adult leatherback sea turtles appear to be linked to the seasonal availability of their prey and the requirements of their reproductive cycles (Collard 1990; Davenport and Balazs 1991). Leatherback sea turtles mate in waters adjacent to nesting beaches and along migratory corridors. They prefer adjacent waters to be deep, clean, and high energy, with either a deep-water oceanic approach or a shallow-water approach (Turtle Expert Working Group 2007). In the Study Area, nesting begins around March in the more northern nesting habitats and continues through July or August in Puerto Rico. Leatherback nesting season begins and ends a few months earlier than that of the other sea turtle species that nest in the Study Area. Females remain in the general vicinity of the nesting habitat between nestings, with total residence in the nesting and inter-nesting habitat lasting up to 4 months (Eckert et al. 1989a; Keinath 1993). After nesting, female leatherbacks migrate from tropical waters to more temperate latitudes, which support high densities of jellyfish prey in the summer.

Gulf Stream and North Atlantic Gyre Open Ocean Areas. The leatherback sea turtle is the most oceanic and wide-ranging of the sea turtles, undertaking extensive migrations in open-ocean waters (Hughes et al. 1998; Morreale et al. 1996). Leatherback sea turtles generally associate with oceanic front systems such as shelf breaks and the edges of oceanic gyre systems where prey is concentrated (Eckert 1993). In the Atlantic Ocean, female leatherback sea turtles have been tracked traveling from nesting beaches in the southern Caribbean due north to waters off Cape Breton Island, Nova Scotia, where they forage for many months (James et al. 2005c). Turtles tagged off Nova Scotia during the summer remained in eastern Canada and northeastern U.S. waters until fall. Most turtles left during October and all migrated south. Some turtles moved to waters near nesting beaches in Central and South America, while others migrated to open-ocean waters between 5° N and 23° N, or to continental shelf waters off the southeastern United States. In February and March, these turtles migrated back to the North Atlantic Ocean, typically arriving in June (James et al. 2005c).

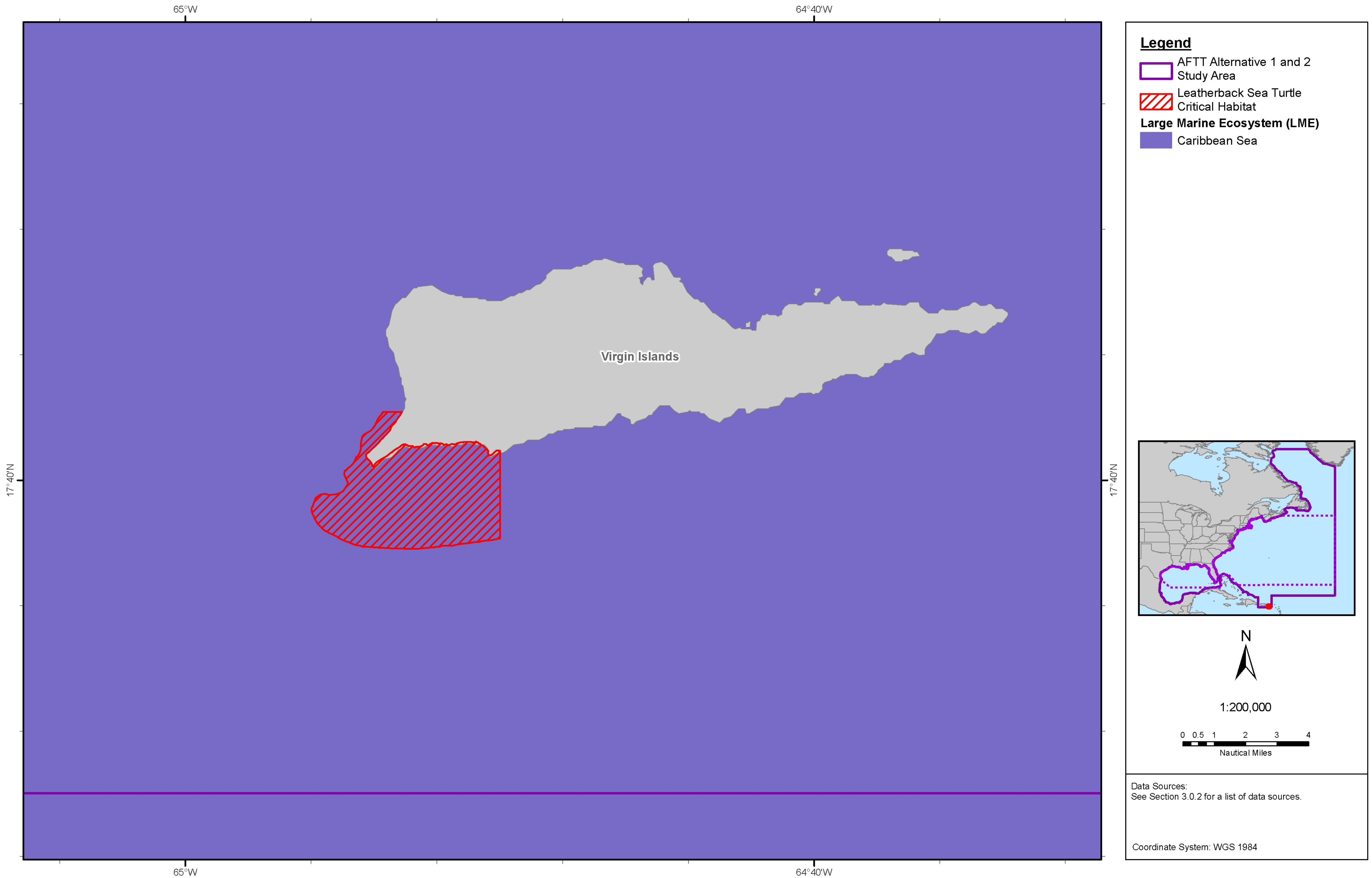

Figure 3.5-3: Critical Habitat Areas for Leatherback Sea Turtles in the Study Area
(the area to the north of purple line shown in this extent of this map)
AFTT: Atlantic Fleet Training and Testing

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Newfoundland-Labrador Shelf and Scotian Shelf Large Marine Ecosystems. Leatherback sea turtles from Western Atlantic stocks are seasonal visitors to the waters of the Scotian Shelf and Gulf of St. Lawrence, occupying shelf and slope waters off Canada and the United States during summer and fall (James et al. 2005c). Sightings and strandings in the Scotian Shelf Large Marine Ecosystem peak in early August, ranking this region as one of the highest in summer and fall densities of leatherbacks in the North Atlantic due to the abundance of jellyfish prey (James et al. 2006).

Northeast U.S. Continental Shelf Large Marine Ecosystem. Aerial surveys off the United States and Nova Scotia coasts sighted a few leatherback sea turtles beyond the 6,560 ft. (2,000 m) isobath, but most were found much nearer to the coast. Turtles were not observed in the winter, while densities increased southward in summer, with the highest concentrations in the coastal waters of Long Island Sound.

Southeast U.S. Continental Shelf Large Marine Ecosystem. Aerial surveys off the southeastern U.S. coast indicate that leatherback sea turtles occur in these waters throughout the year, with peak abundance in summer (Turtle Expert Working Group 2007). In spring, leatherback sea turtles appear to be concentrated near the coast, while other times of the year they are spread out as far as the Gulf Stream. Aerial surveys were conducted by the Navy from 2 August 2009 through 1 August 2010 off Jacksonville, Florida, to assess population abundance within their ranges as part of Atlantic Fleet Active Sonar Training monitoring requirements and to collect baseline data in support of the Undersea Warfare Training Range EIS. These surveys sighted 48 leatherback sea turtles, while simultaneous vessel surveys sighted four leatherback sea turtles (U.S. Department of the Navy 2010). Leatherbacks nest along the east coast of Florida from March through June, from Brevard County south to Palm Beach County in the Southeast U.S. Continental Shelf Large Marine Ecosystem (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c).

Caribbean Sea Large Marine Ecosystem. In the Caribbean, nesting occurs on beaches in Puerto Rico, the U.S. Virgin Islands, and the British Virgin Islands, as well as other islands in the Caribbean Sea Large Marine Ecosystem such as the Dominican Republic and Grenada (The State of the World's Sea Turtles Team 2006). Between 100 and 500 nests are estimated per year in Grenada, St. Kitts, Nevis, St. Lucia, St. Vincent, and the Grenadines (Eckert and Bjorkland 2004).

Gulf of Mexico Large Marine Ecosystem. Leatherback sea turtles occur regularly in the northern Gulf of Mexico, inhabiting deep off-shore waters in the vicinity of DeSoto Canyon for feeding, resting, and migrating (Davis et al. 2000; Landry and Costa 1999). Leatherback sea turtles may also occur in shallow waters on the continental shelf and have been observed feeding on dense aggregations of jellyfish in nearshore waters off the Florida panhandle, the Mississippi River Delta, and the Texas coast (Collard 1990).

3.5.2.8.3 Population and Abundance

Worldwide estimates of leatherback sea turtle populations have varied dramatically over the years as a result of both significant declines in the population and the discovery of new nesting colonies, particularly a colony in Gabon, Africa. Pritchard (1982) estimated 115,000 females worldwide with 60 percent nesting along the Pacific coast of Mexico. However, in 1995, a revised estimate incorporating information from 28 nesting beaches throughout the world yielded about 34,500 females, with a lower limit of about 26,200 and an upper limit of about 42,900 (Spotila et al. 1996). According to the International Union for Conservation of Nature, analysis of published estimates of global population sizes (Pritchard 1982; Spotila et al. 1996) suggest a reduction of greater than 70 percent of the global population of adult females in less than one generation. The populations in the Pacific Ocean have declined drastically in the last decade, with current annual nesting female mortalities estimated at around 30 percent (Sarti Martinez 2000). The most recent population estimate for the North Atlantic alone is a range of 34,000 to 94,000 adult leatherbacks (Turtle Expert Working Group 2007). This wide range indicates the uncertainties in nest numbers and their extrapolation to adult population numbers.

Since 1989, there has been a substantial increase in the nesting population along the east coast of Florida (Turtle Expert Working Group 2007). This increase has coincided with an upsurge in the Caribbean population. Sporadic nesting also occurs in Georgia, South Carolina, as far north as North Carolina (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1992a; Rabon et al. 2003; Schwartz 1989), and in the Gulf of Mexico on the Florida panhandle (Meylan et al. 1995).

Leatherback sea turtles from two of the stocks, the Florida and the Northern Caribbean stocks, nest on beaches in the jurisdiction of the United States. Only the following territories from the Northern Caribbean stock—Puerto Rico, the U.S. Virgin Islands, and the British Virgin Islands—fall within the boundaries of the Study Area. The greatest number of nests recorded within the Caribbean portion of the Study Area is from the Northern Caribbean Stock and occurred on the main island of Puerto Rico at Fajardo, with additional important nesting on the island of Culebra. Nesting increased considerably from 1978, when only nine nests were reported, to the period between 1997 and 2005, which averaged more than 600 nests annually. Increases in nesting similar to those observed in Puerto Rico have occurred at St. Croix since 1978. Nesting in Puerto Rico and the British Virgin Islands (Tortola) peaked in 2003 with 882 and 65 nests, respectively. Nesting in the U.S. Virgin Islands peaked in 2001, when 1,008 total nests were recorded, with 186 individual nesting females in St. Croix. The total number of nests for the Northern Caribbean stock was estimated at 1,600–3,400 for 2005, indicating that between 250 and 1,600 females nest annually, with a point estimate of 640 females. Overall, nesting populations have increased between 4 and 20 percent annually at these three locations (Turtle Expert Working Group 2007). Nesting also peaked for the Florida stock in 2001 with 935 nests. Nesting females from this stock lay between two and eight nests per season, with an average of just under five.

3.5.2.8.4 Predator and Prey Interactions

Leatherbacks lack the crushing chewing plates characteristic of hard-shelled sea turtles that feed on hard-bodied prey (National Marine Fisheries Service 2010). 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 (Aki et al. 1994; Bjorndal 1997; James and Herman 2001; Salmon et al. 2004). As with other sea turtle species, the leatherback's esophagus is lined with papillae (spiny projections) that trap food before swallowing. Leatherback sea turtles feed throughout the water column (Davenport 1988; Eckert et al. 1989b; Eisenberg and Frazier 1983; Grant and Ferrell 1993; James et al. 2005b; Salmon et al. 2004). Leatherback prey is predominantly jellyfish (Aki et al. 1994; Bjorndal 1997; James and Herman 2001; Salmon et al. 2004). In Atlantic Canada, leatherbacks feed on jellyfish of *Cyanea* spp. and *Aurelia* spp. (James and Herman 2001). In North Carolina and Georgia, turtles feed on cannonball jellies (*Stomolophus meleagris*) (Frick et al. 1999; Grant and Ferrell 1993). Patterns in feeding behavior off St. Croix, U.S. Virgin Islands, over a 24-hour period suggest an interaction between leatherback diving and vertical movements of the deep scattering layer (a horizontal zone of planktonic organisms), with more frequent and shallower dives at night compared with fewer and deeper day dives (Eckert et al. 1989b). Research in the feeding grounds of Georgia (Frick et al. 1999), North Carolina (Grant and Ferrell 1993), and Atlantic Canada (James and Herman 2001) has documented leatherbacks foraging on jellyfish at the surface.

Predators of leatherback sea turtles eggs include feral pigs, dogs, raccoons, ghost crabs, and fire ants. As with other sea turtle species, leatherback hatchlings are preyed on by birds and large fish such as tarpon and snapper. Sharks and killer whales are predators of adult leatherbacks (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c).

3.5.2.8.5 Species-Specific Threats

In addition to the general threats described in Section 3.5.2.3 (General Threats), 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 (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c). Shrimp trawls in the Gulf of Mexico have been estimated to capture about 3,000 leatherback sea turtles, with 80 of those sea turtles dying as a result. Along the Atlantic Ocean coast of the United States, NMFS estimated that about 800 leatherback sea turtles are captured in pelagic longline fisheries, bottom longline, and drift gillnet fisheries for sharks as well as lobster, deep-sea red crab, Jonah crab, dolphin fish and wahoo, and Pamlico Sound gillnet fisheries. Although most of these turtles are released alive, these fisheries kill about 300 leatherback sea turtles each year (National Marine Fisheries Service 2011b). Harvest of leatherback sea turtle eggs and adult turtles continues to be a threat in many parts of the world. Lastly, because leatherback sea turtle distribution is so closely associated jellyfish aggregations, any changes in jellyfish distribution or abundance may also be a threat to this species.

3.5.2.9 American Crocodile (*Crocodylus acutus*)

3.5.2.9.1 Status and Management

The American crocodile occurs within the jurisdictional boundaries of many different countries and ranges primarily in coastal waters throughout the Caribbean Sea and on the Pacific coast of Central and South America from Mexico to Ecuador. Population declines have been attributed to loss of habitat and extensive poaching for their hides. The American crocodile was listed as endangered under the ESA throughout its range in the year 1979 (FR 44 (58): 17710-17712, March 23, 1979). In 2007, the Florida population of American crocodiles was reclassified as a distinct population segment and was designated as threatened under the ESA (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007c); the population outside of Florida remains listed as endangered under the ESA. Critical habitat (Figure 3.5-4) was designated for the Florida population in 1976 and was slightly modified in 1977 to include a more accurate map of the habitat (FR 41 (187): 41914-41916, September 24, 1976; FR 44 (244): 75074-75076, December 18, 1979). The essential physical and biological feature of this critical habitat is Florida Bay and its associated brackish marshes, swamps, creeks, and canals because the crocodile population is concentrated in these waters, and all known breeding females inhabit and nest here (FR 41 (187): 41914-41916, September 24, 1976).

3.5.2.9.2 Habitat and Geographic Range

The American crocodile lives primarily in sheltered, fresh, or brackish waters of mangrove-lined bays, mangrove swamps, tidal estuaries, creeks, and inland swamps (FR 41 (187): 41914-41916, September 24, 1976) but also occurs in rivers, lakes, and reservoirs. Crocodiles retreat farther inland during fall and winter. American crocodiles generally occur in water with salinities less than 20 parts per thousand; however they possess salt glands allowing them to excrete excess salt (U.S. Fish and Wildlife Service 1999) and occasionally inhabit more saline environments (e.g., Florida Bay) (Wheatley et al. 2012). Most crocodile sightings in more saline water are females attending nest sites, hatchlings at nest sites, or juveniles presumably avoiding adults (Mazzotti et al. 2007). Females construct nests on elevated, well-drained sites near the water such as ditch banks and beaches. In the United States, artificial nests within berms along canal banks provide nearly ideal nesting conditions because they are elevated, well-drained, and near relatively deep, low-to-intermediate salinity water (Mazzotti et al. 2007). These artificial nesting habitats appear to be compensating for natural habitat elsewhere in Florida and account for much of the increase in nesting documented since 1975.

Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystem. Within the United States, distribution is limited to the southern tip of mainland Florida and the Florida Keys (FR 70 (56): 15052-15063, March 24, 2005), which represents the northern extent of its range. Regular nesting occurs within Biscayne Bay on Florida's east coast, on the border between the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, and there is evidence that the species is expanding its range back into the Florida Keys (Mazzotti et al. 2007).

Most nesting occurs in the Everglades National Park, the cooling water discharge canal of the Turkey Point Power Plant (Homestead, Florida), and Crocodile Lake National Wildlife Refuge in the Gulf of Mexico Large Marine Ecosystem (Mazzotti et al. 2007). Currently, few crocodiles are found north of Biscayne Bay on the Atlantic Coast of Florida, or north of Sanibel Island on Florida's gulf coast (Florida Fish and Wildlife Conservation Commission nd). However, sightings have occurred in the coastal counties of mainland Florida from as far north as Indian River County on the east coast (FR 72 (53): 13027-13040, March 20, 2007) and Lee County on the west coast (U.S. Fish and Wildlife Service 1999).

The American crocodile is known to inhabit inshore marine waters and "are not predisposed to travel across the open ocean" (FR 72 (53): 13027-13040, March 20, 2007). Instead, they prefer calm warm waters with minimal wave action, and most frequently occur in sheltered, mangrove-lined estuaries (Mazzotti 1983). No available evidence suggests that crocodiles cross the Florida Straits (FR 72 (53): 13027-13040, March 20, 2007). Therefore, this species is not expected to occur in offshore areas within the Study Area.

3.5.2.9.3 Population and Abundance

In 1976, the American crocodile population in Florida was estimated to be between 200 and 300 (FR 40 (242): 58308-58312, December 16, 1975), with only 10 to 20 breeding females estimated in 1975 (FR 40 (242): 58308-58312, December 16, 1975). An estimated 20 nests were laid in Florida in 1975. As a result of conservation measures, including habitat protection, the number of nests increased to 85 in 2004 (Mazzotti et al. 2007). In 2007, the population was estimated to be between 1,400 and 2,000, not including hatchlings (FR 72 (53): 13027-13040, March 20, 2007). The species is gradually recovering in the United States, but survey data from Central and South America are relatively poor.

3.5.2.9.4 Predator and Prey Interactions

The American crocodile typically forages from shortly before sunset to shortly after sunrise (U.S. Fish and Wildlife Service 1999). During these times, crocodiles feed on any prey items that can be caught and overpowered (Mazzotti et al. 2007). Adults feed on fish, crabs, birds, turtles, snakes, and small mammals, while young feed on aquatic invertebrates and small fish.

Fire ants are predators of crocodile eggs. Crocodile hatchlings may be preyed on by large fish, birds, other large reptiles and amphibians, or even other crocodiles. Larger juvenile and adult crocodiles have no known predators (Mazzotti et al. 2007).

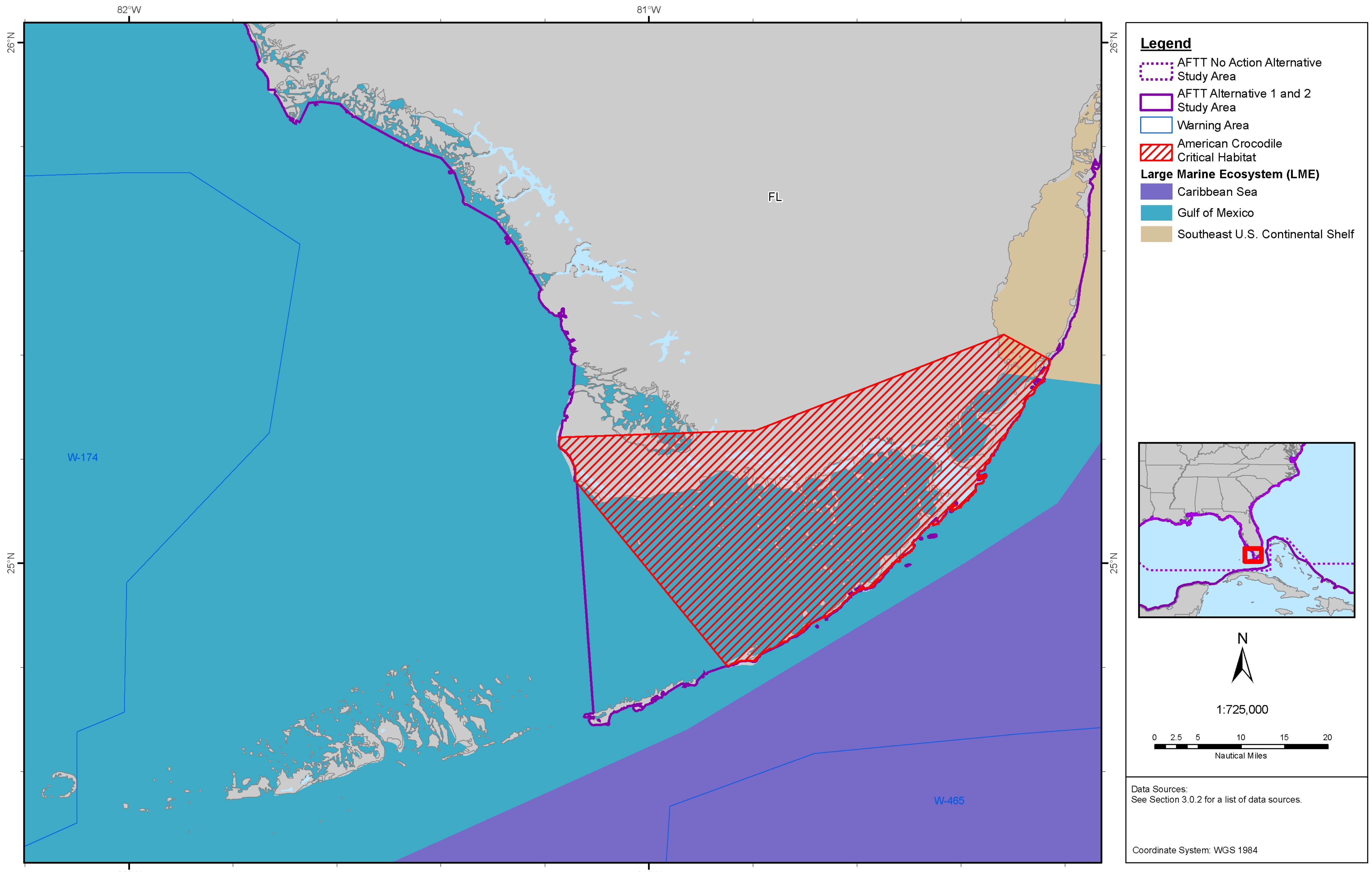

Figure 3.5-4: Critical Habitat Areas for American Crocodiles in the Study Area

AFTT: Atlantic Fleet Training and Testing

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3.5.2.9.5 Species-Specific Threats

Habitat loss is a primary threat to the American crocodile. Development in coastal areas of Florida diminishes American crocodile habitat and restricts the species' breeding range. Erosion or sea level rise may further increase vulnerability of nesting sites. In addition to direct habitat loss, alteration of habitat is a concern. Development restricts freshwater flow into swamps and estuaries, which may limit crocodile growth, survival, and abundance (Mazzotti et al. 2007). Collisions with automobiles are also a documented cause of mortality in Florida's southernmost Miami-Dade and Monroe Counties (Mazzotti et al. 2007).

3.5.2.10 American Alligator (*Alligator mississippiensis*)

3.5.2.10.1 Status and Management

American alligator populations began to decline in the late 1800s, when unregulated hunting for the hides became prevalent, with population numbers close to extinction in some areas (Savannah River Ecology Laboratory 2012a). A hunting ban in the 1950s and other recovery efforts allowed the species to rebound (FR 52 (107): 21059-21064, June 4, 1987). American alligators were listed as an endangered species in 1967 under a law that preceded the ESA of 1973 (National Park Service 2012).

In 1987, the alligator was declared, "no longer biologically threatened or endangered" (FR 52 (107): 21059-21064, June 4, 1987). However, to ensure protections to the American crocodile and other endangered crocodilians, the American alligator is listed under the ESA classification of, "threatened due to similarity of appearance," to the American crocodile (FR 52 (107): 21059-21064, June 4, 1987). Hunting and trade of the American alligator are now permitted and regulated by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service 2008).

3.5.2.10.2 Habitat and Geographic Range

The American alligator's primary habitats are freshwater swamps and marshes but may also include lakes and rivers. Alligators lack lingual salt glands permitting this species a limited capacity to tolerate highly saline environments (Mazzotti and Dunson 1989). In coastal areas, alligators move between freshwater and estuarine waters. Size and sex influences the habitat that alligators reside in; adult males generally prefer deep, open water within coastal water bodies, while adult females prefer coastal open water habitats only during the spring breeding season. After the breeding season, adult females prefer to move to lake and marsh edges during nesting and hatching seasons (Savannah River Ecology Laboratory 2012b). After juveniles have hatched, they remain with the female for up to a year or more for protection during this vulnerable life stage (National Park Service 2012; Savannah River Ecology Laboratory 2012b). Smaller alligators prefer wetlands with dense vegetation for protection and prey advantage (Savannah River Ecology Laboratory 2012a).

Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems. The American alligator resides along the southeastern coast of the United States from North Carolina south through Florida and westward to the Texas coast (Elsey and Woodward 2010).

3.5.2.10.3 Population and Abundance

Following federal legislation, including an ESA listing (FR 52 (107): 21059-21064, June 4, 1987) and the Lacey Act of 1981, alligator populations have rebounded to an estimated total in the millions of individuals (FR 52 (107): 21059-21064, June 4, 1987; (Savannah River Ecology Laboratory 2012b).

3.5.2.10.4 Predator and Prey Interactions

American alligators are opportunistic carnivores. Adults eat a variety of animals, including large fish, turtles, snakes, birds, and small mammals. Hatchlings and smaller alligators eat insects, crayfish, snails and other invertebrates, small fish, and amphibians (Savannah River Ecology Laboratory 2012a).

Alligator eggs are often preyed upon by raccoons, opossums, skunks, pigs, and other terrestrial nest predators. Similarly, young alligators are preyed upon by raccoons, crabs, large snakes, turtles, birds, and even fish (Savannah River Ecology Laboratory 2012b).

3.5.2.10.5 Species-Specific Threats

As described in Section 3.5.2.10.1 (Status and Management), the American alligator population has rebounded after a hunting ban and other recovery efforts. Continuing threats to the American alligator are the same as those described in Section 3.5.2.3.2 (Crocodilians).

3.5.3 Environmental Consequences

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) potentially could impact sea turtles and other marine reptiles known to occur within the Study Area. Tables 2.8-1 through 2.8-3 present the training and testing activity locations for the No Action Alternative, Alternative 1, and the Preferred Alternative, Alternative 2 (including number of activities and ordnance expended). General characteristics of all Navy stressors were introduced in Section 3.0.5.3 (Identification of Stressors for Analysis), and living resources' general susceptibilities to stressors were introduced in Section 3.0.5.7 (Biological Resource Methods). Table F-1 in Appendix F shows all warfare areas and associated stressors that were considered for analysis of all biological resources. Stressors vary in intensity, frequency, duration, and location within the Study Area. Based on the general threats to sea turtles and other marine reptiles discussed in Section 3.5.2 (Affected Environment), the stressors applicable to sea turtles in the Study Area and analyzed below include the following:

- Acoustic (sonar and other active acoustic sources, explosives, pile driving, swimmer defense airguns, weapons firing, launch, and impact noise, vessel noise, aircraft noise)
- Energy (electromagnetic devices and high energy lasers)
- Physical disturbance or strikes (vessels and in-water devices, military expended materials, seafloor devices)
- Entanglement (fiber optic cables, guidance wires, and parachutes)
- Ingestion (munitions and military expended materials other than munitions)
- Secondary stressors

As described in Section 3.0.3 (Ecological Characterization of the Study Area), the Study Area does not extend above the mean high tide line; therefore, land-based stressors and potential impacts on nesting habitats are not discussed in this document. Because the American crocodile and the American alligator are primarily freshwater and estuarine species, they are unlikely to be exposed to many of the stressors associated with Navy training and testing activities which occur in the marine environment in the nearshore and offshore waters of the Northwestern Atlantic Ocean and Gulf of Mexico. The Navy determined through a screening process that, based on the geographic overlap between training and testing activities and the American crocodile and American alligator, only acoustic stressors are applicable and will be analyzed below. All other stressors would not overlap with American crocodile or American alligator habitat and therefore have been excluded from further analysis.

Each of these components is carefully analyzed for potential impacts on sea turtles and other marine reptiles contained in this section. The specific analysis of the training and testing activities considers the components used, the context of geographic location, and overlap of the species. In addition to the analysis here, the details of all training and testing activities, stressors, components that cause the stressor, and geographic overlap within the Study Area are summarized in Section 3.0.5.3 (Identification of Stressors for Analysis) and detailed in Appendix A (Navy Activities Descriptions).

3.5.3.1 Acoustic Stressors

3.5.3.1.1 Sound Producing and Explosive Activities

Assessing whether sounds may disturb or injure an animal involves understanding the characteristics of the acoustic sources, the animals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those animals.

The methods used to predict acoustic effects on sea turtles and crocodilians builds upon the Conceptual Framework for Assessing Effects from Sound Producing Activities (Section 3.0.5.7.1). Additional research specific to sea turtles and crocodilians is presented where available; however, research regarding the impacts of acoustic stressors on crocodilians is limited.

3.5.3.1.2 Analysis Background and Framework

A range of impacts could occur to a marine reptile depending on the sound source. The impacts of exposure to non-explosive, sound-producing activities or to sounds produced by an explosive detonation could include permanent or temporary hearing loss, changes in behavior, and physiological stress. In addition, potential impacts from an explosive impulse can range from physical discomfort to nonlethal and lethal injuries. Immediate nonlethal injury includes slight injury to internal organs and injury to the auditory system, which could reduce long-term fitness. Immediate lethal injury would result from massive combined trauma to internal organs as a direct result of proximity to the point of detonation.

3.5.3.1.2.1 Direct Injury

Potential direct injury from non-impulsive sound sources, such as sonar, is unlikely due to relatively lower peak pressures and slower rise times than potentially injurious sources such as explosives and impact pile driving. Non-impulsive sources also lack the strong shock waves that are associated with explosions. Therefore, primary blast injury and barotrauma would not occur due to exposure to non-impulsive sources such as sonar and are only considered for explosive detonations.

The potential for trauma in sea turtles exposed to impulsive sources (e.g., explosions) has been inferred from tests of submerged terrestrial mammals exposed to underwater explosions (Ketten et al. 1993; Richmond et al. 1973; Yelverton et al. 1973). The effects of an underwater explosion on a sea turtle depend on multiple factors, including size, type, and depth of both the animal and the explosive; depth of the water column; and distance from the charge to the animal. Smaller animals would generally be more susceptible to injury. The compression of blast-sensitive, gas-containing organs when an animal increases depth reduces likelihood of injury to these organs. The location of the explosion in the water column and the underwater environment determines whether most energy is released into the water or the air and influences the propagation of the blast wave. The potential for trauma to crocodilians due to explosions is not evaluated because no use of explosives is proposed in crocodilian habitats.

Primary Blast Injury and Barotrauma

The greatest potential for direct, nonauditory tissue impacts is primary blast injury and barotrauma after exposure to the shock waves of high-amplitude impulsive sources, such as explosions. Primary blast injury refers to those injuries that result from the initial compression of a body exposed to the high pressure of a blast or shock wave. Primary blast injury is usually limited to gas-containing structures (e.g., lung and gut) and the pressure-sensitive components of the auditory system (discussed below) (Craig and Hearn 1998; Craig Jr. 2001; Phillips and Richmond 1990), although additional injuries could include concussive brain damage and cranial, skeletal, or shell fractures (Ketten 1995). Barotrauma refers to injuries caused when large pressure changes occur across tissue interfaces, normally at the boundaries of air-filled tissues such as the lungs. Primary blast injury to the respiratory system, as measured in terrestrial mammals, may consist of lung bruising, collapsed lung, traumatic lung cysts, or air in the chest cavity or other tissues (Phillips and Richmond 1990). These injuries may be fatal, depending on the severity of the trauma. Rupture of the lung may introduce air into the vascular system, possibly producing air blockage that can cause a stroke or heart attack by restricting oxygen delivery to these organs. Although often secondary in life-threatening severity to pulmonary blast trauma, the gastrointestinal tract can also suffer bruising and tearing from blast exposure, particularly in air-containing regions of the tract. Potential traumas include internal bleeding, bowel perforation, tissue tears, and ruptures of the hollow abdominal organs. Although hemorrhage of solid organs (e.g., liver, spleen, and kidney) from blast exposure is possible, rupture of these organs is rarely encountered. Nonlethal injuries could increase a sea turtle's risk of predation, disease, or infection.

Auditory Trauma

Components of the auditory system that detect smaller or more gradual pressure changes can also be damaged when overloaded at high pressures with rapid rise times. Rupture of the eardrum, while not necessarily a serious or life-threatening injury, may lead to permanent hearing loss (Ketten 1995, 1998). No data exist to correlate the sensitivity of the sea turtle eardrum and middle and inner ear to trauma from shock waves associated with underwater explosions (Viada et al. 2008).

The specific impacts of bulk cavitation on sea turtles are unknown. Section 3.0.5.3.1.2 (Explosives) explains cavitation following an explosive detonation. The presence of a sea turtle within the cavitation region created by the detonation of small charges could annoy, injure, or increase the severity of the injuries caused by the shock wave, including injuries to the auditory system or lungs. Presence within the area of cavitation from a large charge, such as those used in ship shock trials, is expected to be an area of almost complete total physical trauma for smaller animals (Craig and Rye 2008). An animal at (or near) the cavitation closure depth would be subjected to a short-duration ("water hammer") pressure pulse; however, direct shock wave impacts alone would be expected to cause auditory system injuries and could cause internal organ injuries.

3.5.3.1.2.2 Hearing Loss

Hearing loss could effectively reduce the distance over which marine reptiles can detect biologically relevant sounds. Both auditory trauma (a direct injury discussed above) and auditory fatigue may result in hearing loss, but the mechanisms responsible for auditory fatigue differ from auditory trauma. Hearing loss due to auditory fatigue does not equate to "deafness" or total hearing loss. Hearing loss due to auditory fatigue is also known as threshold shift, a reduction in hearing sensitivity at certain frequencies. Threshold shift is the difference between hearing thresholds measured before and after an intense, fatiguing sound exposure. Threshold shift occurs when hair cells in the ear fatigue, causing them to become less sensitive over a small range of frequencies related to the sound source to which an animal was exposed. The amount of threshold shift depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. No studies are published on inducing threshold shift in sea turtles; therefore, the potential for the impact on sea turtles or crocodilians must be inferred from studies of threshold shift in other animals.

Temporary threshold shift (TTS) is a hearing loss that recovers to the original hearing threshold over time. An animal may not even be aware of a TTS. It does not become deaf, but requires a louder sound stimulus (related to the amount of TTS) to detect a sound within the affected frequencies. TTS may last several minutes to several days, depending on the intensity and duration of the sound exposure that induced the threshold shift (including multiple exposures).

Permanent threshold shift (PTS) is a permanent hearing loss at a certain frequency range. PTS is nonrecoverable due to the destruction of tissues within the auditory system. The animal does not become deaf but requires a louder sound stimulus (related to the amount of PTS) to detect a sound within the affected frequencies. As the name suggests, the effect is permanent.

3.5.3.1.2.3 Auditory Masking

Auditory masking occurs when a sound prevents or limits the distance over which an animal detects other biologically relevant sounds. When a noise has a sound level above the sound of interest, and in a similar frequency band, auditory masking could occur (Section 3.0.5.7.1, Conceptual Framework for Assessing Effects from Sound-Producing Activities). Any sound above ambient noise levels and within an animal's hearing range may potentially cause masking. The degree of masking increases with increasing noise levels; a noise that is just detectable over ambient levels is unlikely to actually cause any substantial masking, whereas a louder noise may mask sounds over a wider frequency range. In addition, a continuous sound would have more potential for masking than a sound with a low duty cycle. In the open ocean, ambient noise levels are between about 60 and 80 dB re 1 μPa, especially at lower frequencies (below 100 Hz); inshore, ambient noise levels, especially around busy ports, can exceed 120 dB re 1 μPa.

Unlike auditory fatigue, which always results in a localized stress response, behavioral changes resulting from auditory masking may not be coupled with a stress response. Another important distinction between masking and hearing loss is that masking only occurs in the presence of the sound stimulus, whereas hearing loss can persist after the stimulus is gone.

Little is known about how sea turtles use sound in their environment. Based on knowledge of their sensory biology (Bartol and Ketten 2006; Bartol and Musick 2003; Ketten and Moein-Bartol 2006; Levenson et al. 2004), sea turtles may detect objects within the water column (e.g., vessels, prey, predators) via some combination of auditory and visual cues. However, research examining the ability of sea turtles to avoid collisions with vessels shows they may rely more on their vision than auditory cues (Hazel et al. 2007). Similarly, while sea turtles may rely on acoustic cues to identify nesting beaches, they appear to rely on other nonacoustic cues for navigation, such as magnetic fields (Lohmann 1991; Lohmann and Lohmann 1996b) and light (Avens and Lohmann 2003). Additionally, they are not known to produce sounds underwater for communication. As a result, sound may play a limited role in a sea turtle's environment. Therefore, the potential for masking may be limited.

Crocodilians rely on sound for communication, using a repertoire of aerial contact calls, threat hisses, and bellows typically at the water surface (Vergne et al. 2009). Bellows attract other crocodilians and can stimulate a bellowing chorus. The active space for low-frequency American alligator bellows was estimated to be 169 m in air and 1.5 km in water (Todd 2007). Based on the types of sounds used for crocodilian communication, the potential for masking may exist if crocodilians are exposed to lower frequency aerial or in-water noise.

3.5.3.1.2.4 Physiological Stress

Marine reptiles may exhibit a behavioral response or combinations of behavioral responses upon exposure to anthropogenic sounds. If a sound is detected, a stress response (i.e., startle or annoyance) or a cueing response (based on a past stressful experience) can occur. Marine reptiles 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 activities have the potential to provide additional stressors above and beyond those that occur in the absence of human activity.

Immature Kemp's ridley turtles show physiological responses to the acute stress of capture and handling through increased levels of the stress hormone corticosterone, along with biting and rapid flipper movement (Gregory and Schmid 2001). Captive olive ridley hatchlings showed heightened blood glucose levels indicating physiological stress (Rees et al. 2008; Zenteno et al. 2007). Repeated exposure to stressors, including human disturbance such as vessel disturbance and anthropogenic sound, may result in negative consequences to the health and viability of an individual or population (Gregory and Schmid 2001). One factor to consider when predicting a stress or cueing response is whether an animal is naïve or has prior experience with a stressor. Prior experience with a stressor may be of particular importance because repeated experience with a stressor may dull the stress response via acclimation.

3.5.3.1.2.5 Behavioral Reactions

The response of a marine 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 could also affect the way a marine reptile responds to a sound. Potential behavioral responses to anthropogenic sound could include startle reactions, disruption of feeding, disruption of migration, changes in respiration, alteration of swim speed, alteration of swim direction, and area avoidance.

There are limited studies of sea turtle responses to sounds. A few studies examined sea turtle reactions to airguns, which produce broadband impulsive sound. O'Hara and Wilcox (1990) attempted to create a sound barrier at the end of a canal using seismic airguns. They reported that loggerhead turtles kept in a 984 ft. x 148 ft. (300 m x 45 m) enclosure in a 10 m deep canal maintained a standoff range of 98 ft. (30 m) from airguns fired simultaneously at intervals of 15 seconds (s) with strongest sound components within the 25–1,000 Hz frequency range. McCauley et al. (2000) estimated that the received level at which turtles avoided sound in the O'Hara and Wilcox (1990) experiment was 175–176 dB re 1 µPa root mean square.

Moein Bartol et al. (1995) investigated the use of air guns to repel juvenile loggerhead sea turtles from hopper dredges. Sound frequencies of the airguns ranged from 100 to 1,000 Hz at three levels: 175, 177, and 179 dB re 1 µPa at 1 m. The turtles avoided the airguns during the initial exposures (mean range of 24 m), but additional trials several days afterward did not elicit statistically significant avoidance. They concluded that this was due to either habituation or a temporary shift in the turtles' hearing capability.

McCauley et al. (2000) exposed caged green and loggerhead sea turtles to an approaching-departing single air gun to gauge behavioral responses. The trials showed that above a received level of 166 dB re 1 µPa (root mean square), the turtles noticeably increased their swimming activity compared to nonoperational periods, with swimming time increasing as air gun levels increased during approach. Above 175 dB re 1 µPa (root mean square), behavior became more erratic, possibly indicating the turtles were in an agitated state (McCauley et al. 2000). The authors noted that the point at which the turtles showed the more erratic behavior and exhibited possible agitation would be expected to approximate the point at which active avoidance would occur for unrestrained turtles (McCauley et al. 2000).

No obvious avoidance reactions by free-ranging sea turtles, such as swimming away, were observed during a multi-month seismic survey using airgun arrays, although fewer sea turtles were observed when the seismic airguns were active than when they were inactive (Weir 2007). The author noted that sea state and the time of day affected both airgun 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 airgun array in the Mediterranean by basking loggerhead turtles.

No studies have been performed to examine the response of sea turtles to sonar. However, based on their limited range of hearing, they may respond to sources operating below 2 kHz but are unlikely to sense higher frequency sounds (Section 3.5.2.2, Hearing and Vocalization).

Data regarding crocodilian responses to anthropogenic sound is limited. Based on their hearing range, they may respond to aerial and in-water sounds at lower frequencies (less than two kHz).

3.5.3.1.2.6 Repeated Exposures

Repeated exposures of an individual to multiple sound-producing activities over a season, year, or life stage could cause reactions with energetic costs that can accumulate over time to cause long-term consequences for the individual. Conversely, some sea turtles may habituate to or become tolerant of repeated exposures over time, learning to ignore a stimulus that in the past did not accompany any overt threat, such as high levels of ambient noise found in areas of high vessel traffic (Hazel et al. 2007). In an experiment, after initial avoidance reactions, loggerhead sea turtles habituated to repeated exposures to airguns of up to a source level of 179 dB re 1 µPa in an enclosure. The habituation behavior was retained by the sea turtles when exposures were separated by several days (Moein et al. 1994).

3.5.3.1.3 Acoustic and Explosive Thresholds and Criteria

The Navy considers two primary categories of sound sources in its analyses of sound impacts on sea turtles: impulsive sources (e.g., explosives, airguns, weapons firing, and impact pile driving) and non-impulsive sources (e.g., sonar, pingers, and countermeasure devices). General definitions of impulsive and non-impulsive sound sources are provided below. Acoustic impacts criteria and thresholds were developed in cooperation with NMFS for sea turtle exposures to various sound sources. These acoustic impacts criteria are summarized in Table 3.5-2 and Table 3.5-3 and are discussed below. These criteria can be used to estimate the number of sea turtles impacted by testing and training activities that emit sound or explosive energy, as well as the severity of the immediate impacts. These criteria are used to quantify impacts from explosives, swimmer defense airguns, pile driving, sonar, and other active acoustic sources. These criteria are also useful for qualitatively assessing activities that indirectly impart sound to water, such as firing of weapons and aircraft flights.

The criteria presented below are only applicable to sea turtles. Empirical studies and data from which to derive criteria for crocodilians is unavailable; therefore, impacts on the American crocodile and American alligator will be qualitatively discussed based on the limited information available about crocodilian hearing.

Table 3.5-2: Sea Turtle Impact Threshold Criteria for Non-Impulsive Sources

Physiological Thresholds		
Onset[1] PTS	**Onset[1] TTS**	**Injury (Vibratory Pile Driving)**
198 dB SEL (T[2])	178 dB SEL (T[2])	190 dB re 1 μPa SPL root mean square

dB: decibels; μPa: micropascals; PTS: permanent threshold shift; SEL: sound exposure level; SPL: sound pressure level; TTS: temporary threshold shift

[1] When the cetacean criteria were weighted to correlate with Type II frequency weighting, the turtle threshold was inadvertently lowered by 17 dB, even though Type II weighting is not applied to sea turtle hearing. This resulted in an increased number of model-predicted turtle impacts, although the actual impacts are expected to be substantially lower.

[2] (T): Turtle weighting function

Table 3.5-3: Sea Turtle Impact Threshold Criteria for Impulsive Sources

Impulsive Sound Exposure Impact	Threshold Value
Onset Mortality[1] (1% Mortality Based on Extensive Lung Injury)	$= 91.4M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-s$
Onset Slight Lung Injury[1]	$= 39.1M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-s$
Onset Slight Gastrointestinal Tract Injury	237 dB re 1 μPa SPL (104 psi)
Onset PTS[3]	187 dB re 1 μPa^2-s SEL (T[2]) or 230 dB re 1 μPa Peak SPL
Onset TTS[3]	172 dB re 1 μPa^2-s SEL (T[2]) or 224 dB re 1 μPa Peak SPL
Injury (Impact Pile Driving and Airguns)	190 dB re 1 μPa SPL root mean square[4]

dB: decibels, μPa: micropascals; PTS: permanent threshold shift, SEL: sound exposure level, SPL: sound pressure level TTS: temporary threshold shift

[1] M = mass of animals (kg) as shown for each species in Table 3.5-4, D_{Rm} = depth of animal (m). Impulse calculated over a delivery time that is the lesser of either the initial positive pressure duration or 20% of the natural period of the assumed-spherical lung adjusted for animal size and depth.

[2] Turtle weighting function

[3] When the cetacean criteria were weighted to correlate with Type II frequency weighting, the turtle onset PTS and onset TTS SEL-based thresholds were inadvertently lowered, even though Type II weighting is not applied to sea turtle hearing. This resulted in an increased number of model-predicted turtle impacts, although the actual impacts are expected to be substantially lower.

[4] The time interval for determining the root mean square is that which contains 90% of the total energy within the envelope of the pulse. This windowing procedure for impulse signals removes uncertainty about where to set the exact temporal beginning or end of the signal, which may be obscured by ambient noise.

Table 3.5-4: Species-Specific Masses for Determining Onset of Extensive and Slight Lung Injury Thresholds

Common Name	Juvenile Mass (kg)	Reference
Loggerhead Turtle	8.4	Southwood et al (2007)
Green Turtle	8.7	Wood and Wood (1993)
Hawksbill Turtle	7.4	Okuyama et al. (2010)
Kemp's Ridley Turtle	6.3	McVey and Wibbels (1984) and Caillouet (1986)
Leatherback Turtle	34.8	Jones (2009)

3.5.3.1.3.1 Categories of Sounds as Defined for Thresholds and Criteria

Categories of sound are discussed in Section 3.0.4 (Acoustic and Explosives Primer). Impulsive and non-impulsive sounds are described again below with details specific to assigning acoustic and explosive criteria for predicting impacts on sea turtles.

Impulsive Sounds

Impulsive sounds (including explosions) have a steep pressure rise or rapid pressure oscillation, which is the primary reason the impacts of these sounds are considered separately from non-impulsive sounds. Impulsive sounds usually rapidly decay with only one or two peak oscillations and are of very short duration (usually 0.1 s or shorter). Rapid pressure changes may produce mechanical damage to the ear or other structures that would not occur with slower rise times found in non-impulsive signals. Impulsive sources analyzed in this document include explosives, airguns, sonic booms, weapons firing, and impact pile driving.

Non-Impulsive Sounds

Non-impulsive sounds typically contain multiple pressure oscillations without a rapid rise time, although the total duration of the signal may still be quite short (0.1 s or shorter for some high frequency sources). Such sounds are typically characterized by a root mean square average sound pressure level or energy level over a specified period. Sonar and other active acoustic sources (e.g., pingers) are analyzed as non-impulsive sources in this document.

Intermittent non-impulsive sound sources produce sound for only a small fraction of the time that the source is in use (a few seconds or a fraction of a second, e.g., sonar and pingers), with longer silent periods in between the sound. Continuous sources are those that transmit sound for the majority of the time they are being used, often for many minutes, hours, or days. Vibratory pile driving, vessel noise, and aircraft noise are continuous noise sources analyzed in this document.

3.5.3.1.3.2 Criteria for Mortality and Injury from Explosions

There is a considerable body of laboratory data on actual injuries from impulsive sounds, usually from explosive pulses, obtained from tests with a variety of vertebrate species (Goertner et al. 1994; Richmond et al. 1973; Yelverton et al. 1973). Based on these studies, potential impacts, with decreasing likelihood of serious injury or lethality, include onset of mortality, onset of slight lung injury, and onset of slight gastrointestinal injury.

In the absence of data specific to sea turtles, criteria developed to assess impacts on protected marine mammals are also used to assess impacts on protected sea turtles. These criteria are discussed below.

Criteria for Mortality and Slight Lung Injury

In air or submerged, the most commonly reported internal bodily injury due to explosive detonations is hemorrhaging in the fine structure of the lungs. The likelihood of internal bodily injury is related to the received impulse of the underwater blast (pressure integrated over time), not peak pressure or energy (Richmond et al. 1973; Yelverton and Richmond 1981; Yelverton et al. 1973; Yelverton et al. 1975). Therefore, impulse is used as a metric upon which internal organ injury can be predicted. Onset mortality and onset slight lung injury are defined as the impulse level that would result in 1 percent mortality (most survivors have moderate blast injuries and should survive) and zero percent mortality (recoverable, slight blast injuries) in the exposed population, respectively. Criteria for onset mortality and onset slight lung injury were developed using data from explosive impacts on mammals (Yelverton and Richmond 1981).

The impulse required to cause lung damage is related to the volume of the lungs. The lung volume is related to both the size (mass) of the animal and compression of gas-filled spaces at increasing water depth. Turtles have relatively low lung volume to body mass and a relatively stronger anatomical structure compared to mammals; therefore, application of the criteria derived from studies of impacts of explosives on mammals is conservative.

Table 3.5-4 provides a nominal conservative body mass for each sea turtle species based on juvenile mass. Juvenile body masses were selected for analysis given the early rapid growth of these reptiles (newborn turtles weigh less than 0.5 percent of maximum adult body mass). In addition, small turtles tend to remain at shallow depths in the surface pressure release zone, reducing potential exposure to injurious impulses. Therefore, use of hatchling weight would provide unrealistically low thresholds for estimating injury to sea turtles. The use of juvenile body mass rather than hatchling body mass was chosen to produce reasonably conservative estimates of injury.

The scaling of lung volume to depth is conducted for all species since data come from experiments with terrestrial animals held near the water's surface. The calculation of impulse thresholds consider depth of the animal to account for compression of gas-filled spaces that are most sensitive to impulse injury. The impulse required for a specific level of injury (impulse tolerance) is assumed to increase proportionally to the square root of the ratio of the combined atmospheric and hydrostatic pressures at a specific depth with the atmospheric pressure at the surface (Goertner 1982). Additionally, to reach the threshold for onset slight lung injury or onset mortality, the critical impulse value must be delivered during a time period that is the lesser of either the initial positive pressure duration or 20 percent of the natural period of the assumed-spherical lung adjusted for size and depth of the animal. Therefore, as depth increases or animal size decreases, impulse delivery time decreases (Goertner 1982).

Very little information exists regarding the impacts of underwater detonations on sea turtles. Impacts on sea turtles from explosive removal operations range from noninjurious impacts (e.g., acoustic annoyance, mild tactile detection, or physical discomfort) to varying levels of injury (i.e., nonlethal and lethal injuries) (e.g., Klima et al. 1988; Viada et al. 2008). Often, impacts of explosive events on turtles must be inferred from documented impacts on other vertebrates with lungs or other-gas containing organs, such as mammals and most fishes (Viada et al. 2008). The methods used by Goertner (1982) to develop lung injury criteria for marine mammals may not be directly applicable to sea turtles, as it is not known what degree of protection to internal organs from the shock waves is provided to sea turtles by their shell (Viada et al. 2008). However, the general principles of the Goertner model are applicable and should provide a protective approach to assessing potential impacts on sea turtles. The Goertner method predicts a minimum primary positive impulse value associated with onset of slight lung injury and onset of mortality, adjusted for assumed lung volume (correlated to animal mass) and depth of the animal. These equations are shown in Table 3.5-3.

Criteria for Onset of Gastrointestinal Tract Injury

Without data specific to sea turtles, data from tests with terrestrial animals are used to predict onset of gastrointestinal tract injury. It is shown that gas-containing internal organs, such as lungs and intestines, were the principle damage sites from shock waves in submerged terrestrial mammals (Clark and Ward 1943; Greaves et al. 1943; Richmond et al. 1973; Yelverton et al. 1973). Furthermore, slight injury to the gastrointestinal tract may be related to the magnitude of the peak shock wave pressure over the hydrostatic pressure and would be independent of the animal's size and mass (Goertner 1982). Slight contusions to the gastrointestinal tract were reported during small charge tests (Richmond et al. 1973), when the peak was 237 dB re 1 µPa. Therefore, this value is used to predict onset of gastrointestinal tract injury in sea turtles exposed to explosions.

3.5.3.1.3.3 Frequency Weighting

Animals generally do not hear equally well across their entire hearing range. Several studies using green, loggerhead, and Kemp's ridley turtles suggest sea turtles are most sensitive to low-frequency sounds, although this sensitivity varies slightly by species and age class (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 1994; Ridgway et al. 1969). Sea turtles possess an overall hearing range of about 100 Hz to 1 kHz, with an upper limit of 2 kHz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 1994; Ridgway et al. 1969).

Because hearing thresholds are frequency dependent, an auditory weighting function was developed for sea turtles (turtle-weighting, or T-weighting). The T-weighting function simply defines lower and upper frequency boundaries beyond which sea turtle hearing sensitivity decreases. The single frequency cutoffs at each end of the frequency range where hearing sensitivity begins to decrease are based on the most liberal interpretations of sea turtle hearing abilities (10 Hz and 2 kHz). These boundaries are precautionary and exceed the demonstrated or anatomy-based hypothetical upper and lower limits of sea turtle hearing. Figure 3.5-5 shows the sea turtle auditory weighting function with lower and upper boundaries of 10 Hz and 2 kHz, respectively.

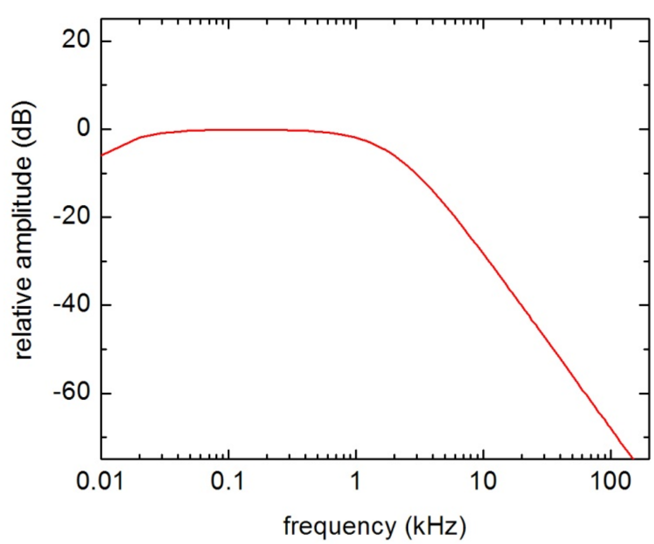

Figure 3.5-5: Auditory Weighting Function for Sea Turtles (T-Weighting)

The T-weighting function adjusts the received sound level based on sensitivity to different frequencies, emphasizing frequencies to which sea turtles are most sensitive and reducing emphasis on frequencies outside of their estimated useful range of hearing. For example, a 160 dB re 1 µPa tone at 10 kHz, far outside sea turtle best range of hearing, is estimated to be perceived by a sea turtle as a 130 dB re 1 µPa sound (i.e., 30 dB lower). Stated another way, a sound outside of the range of best hearing would have to be more intense to have the same impact as a sound within the range of best hearing. Weighting functions are further explained in Section 3.0.4 (Acoustic and Explosives Primer).

3.5.3.1.3.4 Criteria for Hearing Loss – Temporary and Permanent Threshold Shift

Whereas TTS represents a temporary reduction of hearing sensitivity, PTS represents tissue damage that does not recover and permanent reduced sensitivity to sounds over specific frequency ranges (Section 3.5.3.1.2.2, Hearing Loss). To date, no known data are available on potential hearing impairments (i.e., TTS and PTS) in sea turtles. Sea turtles, based on their auditory anatomy (Bartol and Musick 2003; Lenhardt et al. 1985; Wartzok and Ketten 1999; Wever 1978; Wyneken 2001), almost certainly have poorer absolute sensitivity (i.e., higher thresholds) across much of their hearing range than do the mid-frequency cetacean species. Therefore, applying TTS and PTS criteria derived from mid-frequency cetaceans to sea turtles should provide a protective approach to estimating acoustic impacts on sea turtles (PTS and TTS data are not available for low-frequency cetaceans). Criteria for hearing loss due to onset of TTS and PTS are based on sound exposure level (for non-impulsive and impulsive sources) and peak pressure (for impulsive sources only).

To determine the sound exposure level, the turtle weighting function is applied to the acoustic exposure to emphasize only those frequencies within a sea turtle's hearing range. Multiple exposures within any 24-hour period are considered one continuous exposure for the purposes of calculating the received sound exposure level for a given individual. This conservatively assumes no recovery of hearing between exposures during a 24-hour period. The weighted sound exposure level is then compared to weighted threshold values for TTS and PTS. If the weighted exposure level meets or exceeds the weighted threshold, then the physiological impact (TTS or PTS) is assumed to occur. For impacts from exposures to impulsive sources, the metric (peak pressure or sound exposure level) and threshold level that results in the longest range to impact is used to predict impacts. Exposures are not calculated for sound sources with a nominal frequency outside the upper and lower frequency hearing limits for sea turtles.

In addition to being discussed below, thresholds for onset of TTS and PTS for impulsive and non-impulsive sounds are summarized in Tables 3.5-2 and 3.5-3.

Criteria for Non-Impulsive Temporary Threshold Shift

Based on best available science regarding TTS in marine vertebrates (Finneran et al. 2002; Southall et al. 2007) and the lack of information regarding TTS in sea turtles, the total T-weighted sound exposure level of 178 dB re 1 μPa^2-s is used to estimate exposures resulting in TTS for sea turtles. The T-weighting function is used in conjunction with this non-pulse criterion, which effectively provides an upper cutoff of 2 kHz.

The T-weighted non-impulsive TTS threshold of 178 dB re 1 μPa^2-s sound exposure level was inadvertently based on Type II weighted cetacean TTS data rather than Type I weighted cetacean TTS data. This resulted in incorrectly lowering the turtle TTS threshold by 17 dB. The sea turtle non-impulsive TTS threshold, based on mid-frequency cetacean data, should be 17 dB higher than 178 dB re 1 μPa^2-s. Because an incorrectly lowered threshold was used to quantitatively analyze acoustic impacts to sea turtles in this EIS/OEIS, the quantitative impacts presented herein for non-impulsive TTS are conservative (i.e., over-predicted).

Criteria for Impulsive Temporary Threshold Shift

Based on best available science regarding TTS in marine vertebrates (Finneran et al. 2005; Finneran et al. 2000; Finneran et al. 2002; Nachtigall et al. 2003; Nachtigall et al. 2004; Schlundt et al. 2000) and the lack of information regarding TTS in sea turtles, the respective total T-weighted sound exposure level of 172 dB re 1 μPa^2-s or peak pressure of 224 dB re 1 μPa (23 pounds per square inch [psi]) is used to estimate exposures resulting in TTS for sea turtles. The T-weighting function is applied when using the sound exposure level-based thresholds to predict TTS.

The T-weighted impulsive TTS threshold of 172 dB re 1 μPa^2-s sound exposure level was inadvertently based on Type II weighted cetacean TTS data rather than Type I weighted cetacean TTS data. This resulted in incorrectly lowering the turtle TTS threshold. The sea turtle impulsive TTS threshold, based on Type I mid-frequency cetacean data, should be 183 dB re 1 μPa^2-s. Because an incorrectly lowered threshold was used to quantitatively analyze acoustic impacts to sea turtles in this EIS/OEIS, the quantitative impacts presented herein for impulsive TTS are conservative (i.e., over-predicted).

Criteria for Non-Impulsive Permanent Threshold Shift

Since no studies were designed to intentionally induce PTS in sea turtles, levels for onset of PTS for these animals must be estimated using TTS data and relationships between TTS and PTS established in terrestrial mammals. PTS can be estimated based on the growth rate of a threshold shift and the level of threshold shift required to potentially become nonrecoverable. A variety of terrestrial and marine mammal data sources show that threshold shifts up to 40 to 50 dB may be recoverable, and that 40 dB is a reasonable upper limit of a threshold shift that does not induce PTS (Southall et al. 2007). This analysis assumes that continuous-type exposures producing threshold shifts of 40 dB or more always result in some amount of PTS.

Data from terrestrial mammal testing (Ward et al. 1958; Ward et al. 1959) show temporary threshold shift growth of 1.5 to 1.6 dB for every 1 dB increase in sound exposure level. The difference between minimum measureable TTS onset (6 dB) and the 40 dB upper safe limit of TTS yields a difference of 34 dB. When divided by a TTS growth rate of 1.6 dB TTS per dB sound exposure level, there is an indication that an increase in exposure of a 21.25 dB sound exposure level would result in 40 dB of TTS. For simplicity and conservatism, the number was rounded down to 20 dB sound exposure level.

Therefore, non-impulsive exposures of 20 dB sound exposure level above those producing a TTS may be assumed to produce a PTS. The onset of TTS threshold of 178 dB re 1 μPa^2-s for sea turtles has a corresponding onset of PTS threshold of 198 dB re 1 μPa^2-s. The T-weighting function is applied when using the sound exposure level-based thresholds to predict PTS.

The T-weighted non-impulsive TTS threshold of 178 dB re 1 μPa^2-s sound exposure level was inadvertently based on Type II weighted cetacean TTS data rather than Type I weighted cetacean TTS data. This resulted in incorrectly lowering the turtle TTS threshold by 17 dB; consequently, also incorrectly lowering the sea turtle PTS threshold by 17 dB. The sea turtle non-impulsive PTS threshold, based on mid-frequency cetacean data should be 17 dB higher than 198 dB re 1 μPa^2-s. Because an incorrectly lowered threshold was used to quantitatively analyze acoustic impacts to sea turtles in this EIS/OEIS, the quantitative impacts presented herein for non-impulsive PTS are conservative (i.e., over-predicted).

Criteria for Impulsive Permanent Threshold Shift

Since marine mammal and sea turtle PTS data from impulsive exposures do not exist, onset of PTS levels for these animals are estimated by adding 15 dB to the sound exposure level-based TTS threshold and adding 6 dB to the peak pressure-based thresholds. These relationships were derived by Southall et al. (2007) from impulsive noise TTS growth rates in chinchillas. This results in onset of PTS thresholds of total weighted sound exposure level of 187 dB re 1 μPa^2-s or peak pressure of 230 dB re 1 μPa for sea turtles. The T-weighting function is applied when using the sound exposure level-based thresholds to predict PTS.

The T-weighted impulsive PTS threshold of 187 dB re 1 μPa^2-s sound exposure level was inadvertently based on Type II weighted cetacean TTS data rather than Type I weighted cetacean TTS data. This resulted in incorrectly lowering the turtle TTS threshold. The sea turtle impulsive PTS threshold, based on Type I mid-frequency cetacean data, should be 198 dB re 1 μPa^2-s. Because an incorrectly lowered threshold was used to quantitatively analyze acoustic impacts to sea turtles in this EIS/OEIS, the quantitative impacts presented herein for impulsive TTS are conservative (i.e., over-predicted).

3.5.3.1.3.5 Criteria for Behavioral Responses

A sea turtle’s behavioral responses to sound are assumed to be variable and context specific. For instance, a single impulse may cause a brief startle reaction. A sea turtle may swim farther away from the sound source, increase swimming speed, change surfacing time, and decrease foraging if the stressor continues to occur. For each potential behavioral change, the magnitude of the change ultimately would determine the severity of the response. It is assumed that most responses would be short-term avoidance reactions.

A few studies reviewed in section 3.5.3.1.2.5 (Behavioral Reactions) investigated behavioral responses of sea turtles to impulsive sounds emitted by airguns (DeRuiter and Doukara 2012; McCauley et al. 2000; Moein Bartol et al. 1995; O'Hara and Wilcox 1990). There are no studies of sea turtle behavioral responses to sonar. Cumulatively, available airgun studies indicate that perception and a behavioral reaction to a repeated sound may occur with sound pressure levels greater than 166 dB re 1 µPa root mean square, and that more erratic behavior and avoidance may occur at higher thresholds around 175–179 dB re 1 µPa root mean square (McCauley et al. 2000; Moein Bartol et al. 1995; O'Hara and Wilcox 1990). A received level of 175 dB re 1 µPa root mean square is more likely to be the point at which avoidance may occur in unrestrained turtles, with a comparable sound exposure level of 160 dB re 1 μPa^2-s (McCauley et al. 2000). Because information about sea turtle responses to non-impulsive sounds or sounds generated by explosives is limited, the distance from a sound source or explosion within which behavioral responses may occur are estimated using the values associated with sea turtle avoidance of airguns in the above studies. Values for estimating sea turtle responses to pile driving and airguns are discussed in Section 3.5.3.1.3.13 (Criteria for Pile Driving and Swimmer Defense Airguns).

Airgun studies used sources that fired repeatedly over some duration. For single impulses at received levels below threshold shift (hearing loss) levels, the most likely behavioral response is assumed to be a startle response. Since no further sounds follow the initial brief impulse, the biological significance is considered to be minimal.

Based on the limited information regarding significant behavioral reactions of sea turtles to sound, behavioral responses to sounds are qualitatively assessed for sea turtles.

3.5.3.1.3.6 Criteria for Pile Driving and Swimmer Defense Airguns

Existing NMFS risk criteria are applied to sounds generated by pile driving and swimmer defense airguns. The NMFS threshold value for injury to sea turtles due to impact pile driving, vibratory pile driving, and airguns is 190 dB re 1 μPa sound pressure level root mean square.

3.5.3.1.4 Quantitative Analysis

Various computer models and mathematical equations can be used to predict how energy spreads from a sound source (e.g., sonar or underwater detonation) to a receiver (e.g., sea turtle). The Acoustic and Explosives Primer (Section 3.0.4) provides background information about how sound travels through the water. All modeling is an estimation of reality, with simplifications made both to facilitate calculations by focusing on the most important factors and to account for unknowns. For analysis of underwater sound impacts, basic models calculate the overlap of energy and marine life using assumptions that account for the many, variable, and often unknown factors that can greatly influence the result. Assumptions in previous Navy models intentionally erred on the side of overestimation when there were unknowns or when the addition of other variables was not likely to substantively change the final analysis. For example, because the ocean environment is extremely dynamic and information is often limited to a synthesis of data gathered over wide areas requiring many years of research, known information tends to be an average of the wide seasonal or annual variation that is actually present. The Equatorial Pacific El Niño disruption of the ocean-atmosphere system is an example of dynamic change in which unusually warm ocean temperatures are likely to result in the redistribution of marine life and alter the propagation of underwater sound energy. Previous Navy modeling, therefore, made some assumptions indicative of a maximum theoretical propagation for sound energy (such as a perfectly reflective ocean surface and a flat seafloor). More complex computer models build upon basic modeling by factoring in additional variables in an effort to be more accurate by accounting for such things as bathymetry and an animal's likely presence at various depths.

For quantification of estimated marine mammal and sea turtle impacts resulting from sounds produced during Navy activities, the Navy developed a set of data and new software tools. This new approach is the resulting evolution of the basic modeling approaches used by the Navy previously and reflects a much more complex and comprehensive modeling approach as described below.

The quantified results of the sea turtle acoustic impact analysis presented in this Final EIS/OEIS differ from the quantified results presented in the AFTT Draft EIS/OEIS (U.S. Department of the Navy 2012a) due to refinement of training and testing model inputs. The results presented here are well within the framework of the previous National Environmental Policy Act (NEPA) analyses presented in the AFTT Draft EIS/OEIS.

Because limited data is available on crocodilian hearing and because most activities using sonar and explosives would not occur in crocodilian habitat, impacts on crocodilians due to navy training and testing are qualitatively analyzed.

3.5.3.1.5 Navy Acoustic Effects Model

For this analysis of Navy training and testing activities at sea, the Navy developed a set of software tools and compiled data for estimating acoustic impacts. These databases and tools collectively form the Navy Acoustic Effects Model. Details of the Navy Acoustic Effects Model processes and the description and derivation of the inputs are presented in a technical report titled *Determination of Acoustic Effects on Marine Mammals and Sea Turtles for the Atlantic Fleet Training and Testing Environmental Impact*

Statement/Overseas Environmental Impact Statement (Marine Species Modeling Team 2013). The following paragraphs provide an overview of the Navy Acoustics Effects Model process and its more critical data inputs.

The Navy Acoustic Effects Model improves upon previous modeling efforts in several ways. First, unlike earlier methods that modeled sources individually, the Navy Acoustic Effects Model has the capability to run all sources within a scenario simultaneously, providing a more realistic depiction of the potential effects of an activity. Second, previous models calculated sound received levels within set volumes of water and spread animals uniformly across the volumes; in the Navy Acoustic Effects Model, animats (virtual animals) are distributed nonuniformly based on higher resolution species-specific density, depth distribution, and group size information; and animats serve as dosimeters, recording energy received at their location in the water column. Third, a fully three-dimensional environment is used for calculating sound propagation and animat exposure in the Navy Acoustic Effects Model, rather than a two-dimensional environment where the worst case sound pressure level across the water column is always encountered. Finally, current efforts incorporate site-specific bathymetry, sound speed profiles, wind speed, and bottom properties into the propagation modeling process rather than the flat-bottomed provinces used during earlier modeling (Marine Species Modeling Team 2013). The following paragraphs provide an overview of the Navy Acoustic Effects Model process and its more critical data inputs.

Using the best available information on the estimated density of sea turtles in the area being modeled, the Navy Acoustics Effects Model derives an abundance (total number individuals) and distributes the resulting number of animats into an area bounded by the maximum distance that energy propagates out to a criterion threshold value (energy footprint). These animats are distributed based on density differences across the area and known depth distributions (dive profiles). Animats change depths every four minutes but do not otherwise mimic actual animal behaviors (such as avoidance or attraction to a stimulus).

Schecklman et al. (2011) argue that static distributions underestimate acoustic exposure compared to a model with fully three-dimensionally moving animals. However, their static method is different from the Navy Acoustic Effects Model in several ways. First, they distribute the entire population at depth with respect to the species-typical depth distribution histogram, and those animats remain static at that position throughout the entire simulation. In the Navy Acoustic Effects Model, animats are placed horizontally dependent upon nonuniform density information, and then move up and down over time within the water column by interrogating species-typical depth distribution information. Second, for the static method, Schecklman et al. (2011) calculated acoustic received levels for designated volumes of the ocean and then sum the animats that occur within that volume, rather than using the animats themselves as dosimeters, as in the Navy Acoustic Effects Model. Third, they run 50 iterations of the moving distribution to arrive at an average number of exposures, but because they rely on uniform horizontal density (and static depth density), only a single iteration of the static distribution is realized. In addition to moving the animats vertically, the Navy Acoustic Effects Model overpopulates the animats over a nonuniform density and then resamples the population a number of times to arrive at an average number of exposures as well. Tests comparing fully moving distributions and static distributions with vertical position changes at varying rates were compared during development of the Navy Acoustic Effects Model. For position updates occurring more frequently than every five minutes, the number of estimated exposures was similar between the Navy Acoustic Effects Model and the fully moving distribution; however, computational time was much longer for the fully moving distribution.

Navy Acoustics Effects Model calculates the likely propagation for various levels of energy (sound or pressure) resulting from each non-impulse or impulse source used during a training or testing event. This is done taking into account an event location's actual bathymetry and bottom types (e.g., reflective), and estimated sound speeds and sea surface roughness. Platforms (such as a ship using one or more sound sources) are modeled as moving across an area, the size of which is representative of what would normally occur during a training or testing scenario. The model uses typical platform speeds and event durations. Moving source platforms either travel along a predefined track or move along straight-line tracks from a random initial course, reflecting at the edges of a predefined boundary. Static sound sources are stationary in a fixed location for the duration of a scenario. Modeling locations were chosen based on historical data from ongoing activities and in an effort to include all the environmental variation within the study Area where similar events might occur in the future.

The Navy Acoustics Effects Model then tracks the energy received by each animat within the energy footprint of the event and calculates the number of animats having received levels of energy exposures that fall within defined impact thresholds. Predicted effects on the animats within a scenario are then tallied and the highest-order effect (based on severity of criteria; e.g., PTS over TTS) predicted for a given animat is assumed. Each scenario or each 24-hour period for scenarios lasting greater than 24 hours is independent of all others, and therefore, the same individual marine animal could be impacted during each independent scenario or 24-hour period. In a few instances, although the activities themselves all occur within the Study Area, sound may propagate beyond the boundary of the Study Area. Any exposures occurring outside the boundary of the Study Area are counted as if they occurred within the Study Area boundary.

3.5.3.1.6 Model Assumptions and Limitations

There are limitations to the data used in the Navy Acoustics Effects Model, and results must be interpreted within the context of these assumptions. Output from the Navy Acoustic Effects Model relies heavily on the quality of both the input parameters and impact thresholds and criteria. When there was a lack of definitive data to support an aspect of the modeling (such as lack of well-described diving behavior for all marine species), conservative assumptions believed to overestimate the number of exposures were chosen:

- Animats are modeled as being underwater and facing the source and therefore always predicted to receive the maximum sound level at their position within the water column (e.g., the model does not account for conditions such as body shading or an animal raising its head above water).
- Multiple exposures within any 24-hour period are considered one continuous exposure for the purposes of calculating temporary or permanent hearing loss, because there is insufficient data to estimate a hearing recovery function for the time between exposures.
- Animats do not move horizontally (but change their position vertically within the water column), which may overestimate physiological impacts such as hearing loss, especially for slow-moving or stationary sound sources in the model.
- Animats are stationary horizontally and therefore do not avoid the sound source, unlike in the wild where animals would most often avoid exposures at higher sound levels, especially those exposures that may result in PTS.
- Animats are assumed to receive the full impulse of the initial positive pressure wave due to an explosion, although the impulse-based thresholds (onset mortality and onset slight lung injury) assume an impulse delivery time adjusted for animal size and depth. Therefore, these impacts are overestimated at farther distances and increased depths.

- Mitigation measures implemented during training and testing activities that reduce the likelihood of exposing a sea turtle to higher levels of acoustic energy near the most powerful sound sources (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) were not considered in the model.

3.5.3.1.6.1 Sea Turtle Densities

A quantitative analysis of impacts on a species requires data on the abundance and distribution of the species population in the potentially impacted area. The most appropriate metric for this type of analysis is density, which is the number of animals present per unit area. There is no single source of density data for every area of the world, species, and season because of the fiscal costs, resources, and effort involved in providing survey coverage to sufficiently estimate density. Therefore, to characterize the marine species density for large areas such as the Study Area, the Navy compiled data from several sources. To compile and structure the most appropriate database of marine species density data, the Navy developed a protocol to select the best available data sources based on species, area, and time (season). The resulting Geographic Information System database called the Navy Marine Species Density Database includes seasonal density values for every marine mammal and sea turtle species present within the Study Area (U.S. Department of the Navy 2012a).

In this analysis, sea turtle density data were used as an input in the Navy Acoustic Effects Model in their original temporal and spatial resolution. Seasons are defined as winter (December–February), spring (March–May), summer (June–August), and fall (September–November). The density grid cell spatial resolution varied, depending on the original data source utilized. Where data sources overlap, there might be a sudden increase or decrease in density due to different derivation methods or survey data utilized. This is an artifact of attempting to use the best available data for each geographic region. Density data used for the quantitative analysis of acoustic impacts on sea turtles comes from the Navy OPAREA Density Estimate (NODES) and are primarily based on NMFS aerial survey data collected along the U.S. east coast. The aerial surveys covered only a limited coastal area of the U.S. Exclusive Economic Zone. To estimate density beyond the survey coverage area, the farthest offshore Navy OPAREA Density Estimate (NODES) data were extrapolated to the extent of the U.S. Exclusive Economic Zone. To capture the latitudinal variability in sea turtle abundance, the Navy computed the mean density per each remaining OPAREA region not covered by the aerial surveys. Turtle density was determined for each species. Sightings of unknown hardshell species were combined and counted under the species group name hardshell turtles. Hardshell turtles comprise unknown sea turtle sightings that could be a mix of Kemp's ridley, olive ridley, hawksbill, loggerhead, and green sea turtles. In addition, identified green and hawskbill turtles are considered under the hardshell turtle category because too few sightings of these species are available to generate a separate density estimate. Note that for the hardshell turtle category, green turtle dive profile data were used in the Navy Acoustic Effects Model because green turtles are thought to be the majority of individuals represented. The olive ridley sea turtle will not be analyzed because its occurrence in the Study Area is extralimital. For further explanation, see the Navy Marine Species Density Database technical report (U.S. Department of the Navy 2012a).

All species density distributions matched the expected distributions from published literature and the NMFS stock assessments.

3.5.3.1.7 Impacts from Sonar and Other Active Acoustic Sources

Sonar and other active acoustic sound sources emit sound waves into the water to detect objects, safely navigate, and communicate. These systems are used for anti-submarine warfare, mine warfare, navigation, sensing of oceanographic conditions (e.g., sound speed profile), and communication.

General categories of sonar systems are described in Section 2.3 (Description of Sonar, Ordnance/Munitions, Targets, and Other Systems Employed in Atlantic Fleet Training and Testing Events) and Section 3.0.5.3.1 (Acoustic Stressors).

Potential direct impacts on marine reptiles from exposure to sonar or other non-impulsive underwater active acoustic sources include hearing loss due to threshold shift (permanent or temporary), masking of other biologically relevant sounds, physiological stress, or changes in behavior (Section 3.5.3.1.2.1, Direct Injury). Direct injury and barotrauma from a primary blast would not occur from exposure to these sources due to slower rise times and lower peak pressures. As stated above, a TTS can be mild and recovery can take place within a matter of minutes to days and, therefore, is unlikely to cause long-term consequences to individuals or populations. There is no research to indicate whether sea turtles with PTS would suffer long-term consequences. Sea turtles probably do not rely on their auditory systems as a primary sense, although little is known about how sea turtles use the narrow range of low-frequency sounds they might perceive in their environment (Section 3.5.3.1.2.3, Auditory Masking). It is possible that some individuals that experience some degree of permanent hearing loss may have decreased abilities to find resources such as prey or nesting beaches or detect other relevant sounds such as vessel noise, which may lead to long-term consequences for the individual. Similarly, the effect of masking on sea turtles is difficult to assess.

There is little information regarding marine reptile responses to sound. It is anticipated that the intensity of their behavioral response to a perceived sound could depend on several factors, including species, the animal's age, reproductive condition, past experience with the sound exposure, behavior (foraging or reproductive), the received level from the exposure, the type of sound (impulse or nonimpulse), and duration of the sound (Section 3.0.5.7.1, Conceptual Framework for Assessing Effects from Sound-Producing Activities). Any behavioral responses may be short term (seconds to minutes) and of little immediate consequence for the animal, such as simply orienting to the sound source. Alternatively, there may be a longer-term response over several hours such as moving away from the sound source. However, exposure to loud sounds resulting from Navy training and testing at sea would likely be brief because ships and other participants are constantly moving and the animal would likely be moving as well. Animals that are resident during all or part of the year near Navy ports, piers, and nearshore facilities or on fixed Navy ranges are the most likely to experience multiple or repeated exposures. It is likely that a sea turtle could be exposed to sonar and other active acoustic sources multiple times in its lifetime, although the possibility of habituation is unknown. Most exposures would be intermittent and short term when considered over the duration of a sea turtle's life span. In addition, most sources use frequencies that are higher than the best hearing range of sea turtles. Because alligators and crocodiles are found in inland waters, bays, and estuaries, they are not likely to be exposed to most sonar and active acoustic sources used by the Navy.

Most sonar and other active acoustic sources used during training and testing use frequency ranges that are higher than the estimated hearing range of sea turtles (10 Hz to 2 kHz). Therefore, most of these sources have no impact on sea turtle hearing. The limited information on crocodilian hearing indicates that they also likely only sense lower-frequency sounds and would not be able to detect many of the active acoustic sources used during training and testing. Only sonar with source levels greater than 160 dB re 1 µPa using frequencies within the hearing range of sea turtles were modeled for potential acoustic impacts on sea turtles. Other active acoustic sources with low source level, narrow beam width, downward directed transmission, short pulse lengths, frequencies above known hearing ranges, or some combination of these factors are not anticipated to result in impacts on sea turtles. These sources were not modeled and are addressed qualitatively in this EIS/Overseas Environmental Impact Statement

(OEIS) (Section 2.3.7.2, Source Classes Qualitatively Analyzed). These sources generally have frequencies greater than 200 kHz and source levels less than 160 dB re 1 µPa. The types of sources with source levels less than 160 dB are primarily hand-held sonars, range pingers, transponders, and acoustic communication devices. Acoustic impacts on crocodilians were not modeled because they are not present in most areas where training and testing are conducted, and minimal data exist to predict acoustic impacts on crocodilians.

Within this acoustics analysis, the numbers of animals that may receive some form of hearing loss were predicted using the Navy Acoustic Effects Model (Section 3.5.3.1.5). To quantify the impacts of acoustic exposures to sea turtles, training and testing activities were modeled that employ acoustic sources using frequencies in the hearing range of sea turtles. These activities and the acoustic source classes used are listed in Table 3.5-5. Most sonar and active acoustic sources used during training and testing use frequencies outside the estimated hearing range of turtles.

Table 3.5-5: Activities and Active Acoustic Sources Modeled and Quantitatively Analyzed for Acoustic Impacts on Sea Turtles

Activity	Acoustic Source Class[1]
Training Activities	
ASW for Joint Task Force Exercise	ASW2
ASW for Composite Training Unit Exercise	ASW2
Group Sail	ASW2
TRACKEX/TORPEX-Surface	ASW1, MF12
TRACKEX-Maritime Patrol Aircraft	ASW2
Testing Activities	
ASW Tracking Test: Maritime Patrol Aircraft	ASW2
Surface Combatant Sea Trials: ASW Testing	MF9, MF10
Surface Combatant Sea Trials: Pierside Sonar Testing	MF9, MF10
Submarine Sea Trial: ASW Testing	MF10
Littoral Combat Ship Mission Package Testing: ASW	MF12
Surface Ship Sonar Testing/Maintenance	MF9, MF10
UUV Demonstration (NSWC PCD)	LF4, MF9
Special Warfare Testing (NSWC PCD)	MF9
Stationary Source Testing (NSWC PCD)	LF4, MF8
Towed Equipment Testing (NUWCDIVNPT)	LF4, MF9, SAS1
Unmanned Underwater Vehicle (UUV) Testing (NUWCDIVNPT)	LF5
Semi-stationary Equipment Testing (NUWCDIVNPT)	LF4, LF5, MF9, MF10
UUV Demonstration (NUWCDIVNPT)	LF4, MF9
Signature Analysis Activities (SFOMF)	LF4, ASW2
Surface Testing Activities (SFOMF)	LF5, MF9
UUV Demonstration (SFOMF)	LF4, MF9
Sonobuoy Lot Acceptance Testing	ASW2
Pierside Integrated Swimmer Defense Testing	LF4, MF8
Unmanned Vehicle Development and Payload Testing	MF9
Special Warfare	MF9

ASW: anti-submarine warfare; LF: low frequency; MF: mid frequency; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; TORPEX: torpedo exercise; TRACKEX: tracking exercise; UUV: unmanned underwater vehicle

[1] Characteristics of acoustic source classes are described in Section 2.3.7 (Classification of Acoustic and Explosive Sources)

3.5.3.1.7.1 Model-Predicted Impacts

Table 3.5-6 through Table 3.5-8 show predicted impacts on sea turtles from the Navy Acoustics Effects Model. The exposure estimates for each alternative represent the total number of exposures and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year. The predicted acoustic impacts do not take into account mitigation measures, such as establishing shut-down zones for certain sonar systems (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

Table 3.5-6: Annual Total Model-Predicted Impacts on Sea Turtles for Training Activities Using Sonar and Other Active Non-Impulsive Acoustic Sources

Sea Turtle Species or Group	No Action Alternative		Alternative 1		Alternative 2	
	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]
Hardshell Turtles[1]	218	0	12,131	11	12,131	11
Kemp's Ridley Turtle	17	0	263	0	263	0
Loggerhead Turtle	310	0	16,624	16	16,624	16
Leatherback Turtle	401	1	8,806	9	8,806	9

[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

Table 3.5-7: Annual Total Model-Predicted Impacts on Sea Turtles for Testing Activities Using Sonar and Other Active Non-Impulsive Acoustic Sources

Sea Turtle Species or Group	No Action Alternative		Alternative 1		Alternative 2	
	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]
Hardshell Turtles[1]	62	0	3,647	0	4,021	0
Kemp's Ridley Turtle	3	0	193	0	213	0
Loggerhead Turtle	96	0	4,393	0	4,847	0
Leatherback Turtle	38	0	671	0	741	0

[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

Table 3.5-8: Model-Predicted Impacts for Unmanned Underwater Vehicle Demonstrations (Testing) Using Sonar (Occurs Once per Five-Year Period at Each Location)

Sea Turtle Species or Group	NSWC Panama City (all Alternatives)		SFOMF (Alternatives 1 and 2 only)		NUWC Newport (all Alternatives)	
	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]
Hardshell Turtles[1]	20	0	921	0	3	0
Kemp's Ridley Turtle	0	0	65	0	0	0
Loggerhead Turtle	139	0	1,142	0	7	0
Leatherback Turtle	21	0	40	0	2	0

NSWC: Naval Surface Warfare Center, Panama City Division Testing Range; NUWC: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range

[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.

[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

As discussed above (Section 3.5.3.1.6, Model Assumptions and Limitations), within the Navy Acoustic Effects Model, animats (virtual animals) do not move horizontally or react in any way to avoid sound at any level. At close ranges and high sound levels approaching those that could cause PTS, avoidance of the area immediately around the sound source is the assumed behavioral response for most cases. Furthermore, cues preceding the commencement of the event (e.g., vessel presence and movement, aircraft overflight) may result in some animals departing the immediate area, even before active sound sources begin transmitting.

Since animal avoidance and mitigation measures are not considered in the Navy Acoustic Effects Model, the model-predicted non-impulsive PTS are adjusted to produce the final quantitative predictions shown below. During the first few pings of an event, or after a pause in sonar operations, if animals are caught unaware and mitigation measures are not yet implemented (e.g., animals are at depth and not visible at the surface) it is possible that they could receive enough acoustic energy to suffer PTS. Therefore, predicted PTS exposures from the Navy Acoustic Effects Model for three to four pings are considered in most activities, with the remainder of the model-predicted PTS considered TTS for this analysis.

3.5.3.1.7.2 No Action Alternative

Training Activities

Training activities under the No Action Alternative include activities that produce non-impulsive noise from the use of sonar and other active acoustic sources that fall within the hearing range of sea turtles. These activities could occur throughout the Study Area but would be concentrated in the Virginia Capes (VACAPES), Navy Cherry Point, and Jacksonville (JAX) Range Complexes. The number of events and their proposed locations are presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Use of sonar and other active acoustic sources during training activities is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

Model-predicted acoustic impacts on sea turtles from exposure to sonar and other active acoustic sources for annually recurring training activities under the No Action Alternative are shown in Table 3.5-6. The results shown are the impacts on sea turtles predicted for one year of training. The majority of impacts on all sea turtle species would occur due to major training activities (source class ASW2 in Composite Training Unit Exercise and Joint Task Force Exercise) in the JAX Range Complex. These events would occur a limited number of times per year, but each event would last for multiple days. Therefore, some animals may be exposed multiple times over the course of a few days.

Most impacts are predicted to occur in the Southeast U.S. Continental Shelf Large Marine Ecosystem. A smaller, but notable, portion of impacts are also predicted in the Gulf Stream Open Ocean Area. Sea turtles in the Gulf Stream Open Ocean Area would typically be post-hatchlings, juveniles, or migrating adults, while sea turtles in the Southeast U.S. Continental Shelf Large Marine Ecosystem would typically be foraging adults and juveniles. Because these sound sources would typically be used beyond 12 nm from shore, they are unlikely to impact sea turtles near nesting beaches.

Some sea turtles are predicted to experience TTS, which would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure. One leatherback sea turtle is predicted to experience PTS due to training with sonar and other active acoustic sources, which would permanently reduce perception of sound within a limited frequency range. This long-term consequence could impact an individual turtle's ability to sense biologically important sounds such as predators or prey, reducing that animal's fitness; however, because most sounds are broadband, a reduction in sensitivity over a small portion of hearing range may not interfere with perception of most sounds.

Cues preceding the commencement of the event (e.g., vessel presence and movement, aircraft overflight) may result in some animals departing the immediate area, even before active sound sources begin transmitting. Avoidance behavior could reduce the sound exposure level experienced by a sea turtle and therefore reduce the likelihood and degree of TTS predicted near sound sources. In addition, PTS and TTS threshold criteria for sea turtles are conservatively based on criteria developed for mid-frequency marine mammals. Therefore, actual TTS impacts are expected to be substantially less than the predicted quantities.

Sea turtles may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the immediate area around a source, although studies examining sea turtle behavioral responses to sound have used impulsive sources, not non-impulsive sources. Pronounced reactions to acoustic stimuli could lead to a sea turtle expending energy and missing opportunities to forage or breed. In most cases, acoustic exposures are intermittent, allowing time to recover from an incurred energetic cost, resulting in no long-term consequence.

Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts.

Within the Study Area, critical habitat has been designated in the marine environment for the following sea turtle species: green sea turtles (waters out to 3 nm around Culebra Island, Puerto Rico, due to their importance as developmental and foraging habitat [Figure 3.5-1]), hawksbill sea turtles (waters out to 3 nm around Mona and Monito Islands, Puerto Rico, due to their importance as developmental and foraging habitat [Figure 3.5-2]), and leatherback sea turtles (waters inclusive of the 100 fathom curve shoreward off Sand Point, St. Croix, U.S. Virgin Islands, for mating and migratory access of the turtles to and from the nesting beach [Figure 3.5-3]). At the time of these critical habitat designations no primary constituent elements were listed to define the critical habitat. Sonar and other active acoustic sources within the hearing range of sea turtles are not proposed for use in the nearshore waters in or near these critical habitats. Any use of these sources near these waters would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill sea turtles or mating and nesting activities for the leatherback sea turtle.

The American alligator and the American crocodile are primarily freshwater or estuarine species. Based on limited data on crocodilian hearing, they may be capable of detecting low-frequency and some mid-frequency sounds produced by training with sonar and other active acoustic sources. Training with active acoustic sources would not occur near the swamps and estuaries in southern Florida that are American crocodile habitat; therefore, American crocodiles are not expected to be impacted by these activities. American alligators may be found along the Southeast Atlantic and Gulf coasts and could be exposed to mid-frequency sonar during surface ship and submarine sonar maintenance and navigational activities that occur near shore around naval ports; however, American alligators are not typically present in such saline waters. It is unknown whether an alligator exposed to underwater sound due to these sonar would be able to detect these mid-frequency sources and, if so, whether it would respond. Any impacts on American alligators are expected to be minimal.

Within the Study Area, critical habitat has been designated for the American crocodile in South Florida (Figure 3.5-4). No primary constituent elements were identified during the designation of this habitat. Sonar and other active acoustic sources would not be used in the nearshore shallow waters in or near the critical habitat. Any use of these sources near these waters would not result in the destruction or impairment to the ability of the habitat to support American crocodile populations.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under the No Action Alternative:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles;*
- *may affect but is not likely to adversely affect ESA-listed American alligators; and*
- *will have no effect on sea turtle and American crocodile critical habitats.*

Testing Activities

Testing activities under the No Action Alternative include activities that produce non-impulsive noise from the use of sonar and other active acoustic sources that fall within the hearing range of sea turtles. These activities would typically occur in all of the range complexes; at Naval Surface Warfare Center, Panama City Division Testing Range; and at Naval Undersea Warfare Center Division, Newport Testing Range. The number of events and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of sonar and other active acoustic sources is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

Model-predicted acoustic impacts on sea turtles from exposure to sonar and other active acoustic sources under the No Action Alternative are shown in Table 3.5-7 for annually recurring testing activities and in Table 3.5-8 for unmanned underwater vehicles demonstrations that do not occur annually. The results shown in Table 3.5-7 are predicted impacts for one year of testing activities.

Although impacts could occur across all of the range complexes and training ranges due to various types of testing involving active acoustic sources, the portion of total predicted impacts are greater for certain activities, either due to the types of sources or the hours of use. For annual testing, the following types of activities at the locations noted produce the majority of predicted impacts: anti-submarine warfare tracking test – Maritime Patrol Aircraft (in the Northeast, VACAPES, Navy Cherry Point, and JAX Range Complexes), special warfare (Key West Range Complex), unmanned underwater vehicle testing (Naval Surface Warfare Center, Panama City Division Testing Range), and semi-stationary equipment testing (Naval Undersea Warfare Center Division, Newport Testing Range). An unmanned underwater vehicle demonstration event would not occur annually but could occur once at Naval Surface Warfare Center, Panama City Division Testing Range and once at Naval Undersea Warfare Center Division, Newport Testing Range over a five-year period. Testing events using sonar and other active acoustic sources are often multiday events during which active sources are used intermittently; therefore, some animals may be exposed multiple times over the course of a few days.

Predicted impacts due to annual testing are concentrated in the Southeast U.S. Continental Shelf Large Marine Ecosystem and in the Gulf Stream Open Ocean Area. Smaller, but notable, portions of impacts are also predicted in the Northeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems. While most testing using anti-submarine warfare sonar would occur beyond 12 nm from shore, other testing activities using active acoustic sources may occur closer to shore, specifically at Naval Surface Warfare Center, Panama City Division Testing Range and at Naval Undersea Warfare Center Division, Newport Testing Range. In addition, testing of sonar systems could occur at multiple pierside locations. The addition of an unmanned underwater vehicle demonstration in any given year could increase impacts on sea turtles in nearshore areas in the Gulf of Mexico and Northeast U.S. Continental Shelf Large Marine Ecosystems. Sea turtles in the Gulf Stream Open Ocean Area would typically be post-hatchlings, juveniles, or migrating adults, while sea turtles in the other Large Marine Ecosystems would typically be adults and juveniles.

Some sea turtles are predicted to experience TTS, which would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure. Cues preceding the commencement of the event (e.g., vessel presence and movement, aircraft overflight) may result in some animals departing the immediate area, even before active sound sources begin transmitting. Avoidance behavior could reduce the sound exposure level experienced by a sea turtle and therefore reduce the likelihood and degree of TTS predicted near sound sources. In addition, PTS and TTS threshold criteria for sea turtles are conservatively based on criteria developed for mid-frequency marine mammals. Therefore, actual TTS impacts are expected to be substantially less than the predicted quantities.

Sea turtles may exhibit short-term behavioral reactions, such as swimming away or diving to avoid the immediate area around a source, although studies examining sea turtle behavioral responses to sound have used impulsive sources, not non-impulsive sources. Pronounced reactions to acoustic stimuli could lead to a sea turtle expending energy and missing opportunities to forage or breed. In nesting season, near nesting beaches (in the Southeast U.S. Continental Shelf, Caribbean, and Gulf of Mexico Large Marine Ecosystems), behavioral disturbances may interfere with nesting beach approach. In most cases, acoustic exposures are intermittent, allowing time to recover from an incurred energetic cost, resulting in no long-term consequence.

Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness) to most individuals. Therefore, population-level impacts are not expected.

Within the Study Area, critical habitat has been designated in the marine environment for the following sea turtle species: green sea turtles (waters out to 3 nm around Culebra Island, Puerto Rico, due to their importance as developmental and foraging habitat [Figure 3.5-1]), hawksbill sea turtles (waters out to 3 nm around Mona and Monito Islands, Puerto Rico, due to their importance as developmental and foraging habitat [Figure 3.5-2]), and leatherback sea turtles (waters inclusive of the 100 fathom curve shoreward off Sand Point, St. Croix, United States Virgin Islands, for mating and migratory access of the turtles to and from the nesting beach [Figure 3.5-3]). At the time of these critical habitat designations, no primary constituent elements were listed to define the critical habitat. Sonar and other active acoustic sources within the hearing range of sea turtles are not proposed for use in the nearshore waters in or near these critical habitats. Any use of these sources near these waters would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill turtles or mating and nesting activities for the leatherback sea turtle.

The American alligator and the American crocodile are primarily freshwater or estuarine species. Based on limited data on crocodilian hearing, they may be capable of detecting low-frequency and some mid-frequency sounds produced by testing with sonar and other active acoustic sources. Testing with active acoustic sources would not occur near the swamps and estuaries in southern Florida that are American crocodile habitat; therefore, American crocodiles are not expected to be impacted by these activities. American alligators may be found along the southeast Atlantic and Gulf coasts and could be exposed mid-frequency sonar during pierside sonar testing; however, American alligators are not typically present in such saline waters. It is unknown whether an alligator exposed to underwater sound due to sonar would be able to detect these mid-frequency sources and, if so, whether it would respond. Any impacts on American alligators are expected to be minimal.

Within the Study Area, critical habitat has been designated for the American crocodile in South Florida (Figure 3.5-4). No primary constituent elements were identified during the designation of this habitat. Sonar and other active acoustic sources would not be used in the nearshore shallow waters in or near the critical habitat. Any use of these sources near these waters would not result in the destruction or impairment of the ability of the habitat to support American crocodile populations.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under the No Action Alternative:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles;*
- *may affect but is not likely to adversely affect ESA-listed American alligators; and*
- *will have no effect on sea turtle and American crocodile critical habitats.*

3.5.3.1.7.3 Alternative 1

Training Activities

The number of annual training activities that produce in-water noise from the use of sonar and other active acoustic sources that fall within the hearing range of sea turtles under Alternative 1 would increase compared to the No Action Alternative. These activities could occur in the VACAPES, Navy

Cherry Point, and JAX Range Complexes. Use of sonar and other active acoustic sources during training activities is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

Model-predicted acoustic impacts on sea turtles from exposure to sonar and other active acoustic sources for annually recurring training activities under Alternative 1 are shown in Table 3.5-6. The results shown are the impacts on sea turtles predicted for one year of training. The impacts are predicted to increase compared to the No Action Alternative. Similar to the No Action Alternative, impacts could occur throughout the Study Area but would be concentrated in the Southeast U.S. Continental Shelf Large Marine Ecosystem and in the Gulf Stream Open Ocean Area. The majority of impacts on all sea turtle species would occur due to major training activities (source class ASW2 in Composite Training Unit Exercise and Joint Task Force Exercise) in the JAX Range Complex. Most of the increase in predicted impacts over the No Action Alternative is due to additional anti-submarine warfare training during major training activities. These events would occur a limited number of times per year, but each event would last for multiple days. Therefore, some animals may be exposed multiple times over the course of a few days.

Some sea turtles are predicted to experience TTS, which would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure. Nine leatherback, 16 loggerhead, and 11 hardshell sea turtles are predicted to experience PTS due to training with sonar and other active acoustic sources, which would permanently reduce perception of sound within a limited frequency range. This long-term consequence could impact an individual turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness; however, because most sounds are broadband, a reduction in sensitivity over a small portion of hearing range may not interfere with perception of most sounds.

The increase in predicted impacts on sea turtles could mean an increase in the number of individual animals exposed per year or an increase in the number of times per year some animals are exposed, when compared to the No Action Alternative. However, the expected impacts on any individual sea turtle remain the same. Similarly, the model may over-predict acoustic impacts because the criteria to predict impacts are conservative. For the reasons provided in Section 3.5.3.1.7.2 (No Action Alternative), potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness) to most individuals. Although some individuals may experience long-term impacts, population-level impacts are not expected.

The potential impacts on the American alligator and the American crocodile are similar to those under the No Action Alternative in Section 3.5.3.1.7.2 (No Action Alternative). American crocodiles would not be impacted by sonar and other active acoustic sources, but American alligators may be exposed in some nearshore areas. Similar to the No Action Alternative, sea turtle and American crocodile critical habitats would not be impacted by training with sonar and other active acoustic sources.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under Alternative 1:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles;*
- *may affect but is not likely to adversely affect ESA-listed American alligators; and*
- *will have no effect on American crocodile and sea turtle critical habitats.*

Testing Activities

Testing activities under Alternative 1 that produce in-water noise from the use of sonar and other active non-impulsive acoustic sources that fall within the hearing range of sea turtles would increase compared to the No Action Alternative. Testing could occur in all of the range complexes; at Naval Surface Warfare Center, Panama City Division Testing Range; at Naval Undersea Warfare Center Division, Newport Testing Range; and at the South Florida Ocean Measurement Facility Testing Range. The number of events and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of sonar and other active acoustic sources is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

Model-predicted acoustic impacts on sea turtles from exposure to sonar and other active acoustic sources under the No Action Alternative are shown in Table 3.5-7 for annually recurring testing activities and in Table 3.5-8 for unmanned underwater vehicles demonstrations that do not occur annually. The results shown in Table 3.5-7 are predicted impacts for one year of testing activities. The impacts are predicted to increase compared to the No Action Alternative. The majority of these increases are attributed to the addition of testing activities at the South Florida Ocean Measurement Facility Testing Range, sonobuoy lot testing at the Key West Range Complex, and unmanned vehicle development and payload testing at multiple locations.

Although impacts could occur across all of the range complexes and training ranges due to various types of testing involving active acoustic sources, the portion of total predicted impacts are greater for certain activities, either due to the types of sources or the hours of use. For annual testing, the following types of activities at the locations noted produce the majority of predicted impacts: surface testing activities (South Florida Ocean Measurement Facility Testing Range), unmanned vehicle development and payload testing (Northeast, VACAPES, Navy Cherry Point, JAX, and Gulf of Mexico [GOMEX] Range Complexes), and sonobuoy lot acceptance Testing (Key West Range Complex). An unmanned underwater vehicle demonstration would not occur annually but could occur once at Naval Surface Warfare Center, Panama City Division Testing Range; once at Naval Undersea Warfare Center Division, Newport Testing Range; and once at the South Florida Ocean Measurement Facility Testing Range over a five-year period. Testing events using sonar and other active acoustic sources are often multiday events during which active sources are used intermittently; therefore, some animals may be exposed multiple times over the course of a few days.

Predicted impacts due to annual testing are concentrated in the Southeast U.S. Continental Shelf Large Marine Ecosystem, the Caribbean Sea Large Marine Ecosystem, and the Gulf Stream Open Ocean Area. While most testing using anti-submarine warfare sonar would occur beyond 12 nm from shore, other testing activities using active acoustic sources may occur closer to shore, specifically at Naval Surface Warfare Center, Panama City Division Testing Range and at Naval Undersea Warfare Center Division, Newport Testing Range. In addition, testing of sonar systems could occur at multiple pierside locations. The addition of an unmanned underwater vehicle demonstration in any given year could increase impacts on sea turtles in nearshore areas in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems. Sea turtles in the Gulf Stream Open Ocean Area would typically be post-hatchlings, juveniles, or migrating adults, while sea turtles in the other large marine ecosystems would typically be adults and juveniles.

The increase in predicted impacts on sea turtles could mean an increase in the number of individual animals exposed per year or an increase in the number of times per year some animals are exposed when compared to the No Action Alternative. However, the expected impacts on any individual sea turtle remain the same. Similarly, the model may over predict acoustic impacts because the criteria to predict impacts are conservative. For the reasons provided in Section 3.5.3.1.7.2 (No Action Alternative), potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness) of most individuals. Although some individuals may experience long-term impacts, population-level impacts are not expected.

The potential impacts on the American alligator and the American crocodile are similar to those under the No Action Alternative in Section 3.5.3.1.7.2 (No Action Alternative). American crocodiles would not be impacted by sonar and other active acoustic sources, but American alligators may be exposed in some nearshore areas. Similar to the No Action Alternative, sea turtle and American crocodile critical habitats would not be impacted by testing with sonar and other active acoustic sources.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 1:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles;*
- *may affect but is not likely to adversely affect ESA-listed American alligators; and*
- *will have no effect on American crocodile and sea turtle critical habitats.*

3.5.3.1.7.4 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be identical as described in Section 3.5.3.1.7.3 (Alternative 1).

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under Alternative 2:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles;*
- *may affect but is not likely to adversely affect ESA-listed American alligators; and*
- *will have no effect on American crocodile and sea turtle critical habitats.*

Testing Activities

Testing activities under Alternative 2 that produce in-water noise from the use of sonar and other active non-impulsive acoustic sources that fall within the hearing range of sea turtles would increase compared to the No Action Alternative. Compared to Alternative 1, the activities using sonar and other active acoustic sources would increase by about 10 percent, but the types of testing activities and the locations they occur would be the same as those under Alternative 1. The number of events and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of sonar and other active acoustic sources is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

The increase in predicted impacts on sea turtles could mean an increase in the number of individual animals exposed per year or an increase in the number of times per year some animals are exposed, when compared to the No Action Alternative. However, the expected impacts on any individual sea turtle remain the same. Similarly, the model may over-predict acoustic impacts because the criteria to predict impacts are conservative. For the reasons provided in Section 3.5.3.1.7.2 (No Action Alternative), potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness) of most individuals. Although some individuals may experience long-term impacts, population-level impacts are not expected.

The potential impacts on the American alligator and the American crocodile are similar to those under the No Action Alternative in Section 3.5.3.1.7.2 (No Action Alternative). American crocodiles would not be impacted by sonar and other active acoustic sources, but American alligators may be exposed in some nearshore areas. Similar to the No Action Alternative, sea turtle and American crocodile critical habitats would not be impacted by testing with sonar and other active acoustic sources.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 2:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles;*
- *may affect but is not likely to adversely affect ESA-listed American alligators; and*
- *will have no effect on American crocodile and sea turtle critical habitats.*

3.5.3.1.8 Impacts from Explosives

Explosions in the water or near the water's surface can introduce loud, impulsive, broadband sounds into the marine environment. These sounds are likely within the audible range of most sea turtles, but the duration of individual sounds is very short. Energy from explosions is capable of causing mortalities, injuries to the lungs or gastrointestinal tract (Section 3.5.3.1.2.1, Direct Injury), TTS or PTS (Section 3.5.3.1.2.2, Hearing Loss), or behavioral responses (Section 3.5.3.1.2.5, Behavioral Reactions). The impacts on sea turtles from at-sea explosions depend on the net explosive weight of the charge, depth of the charge, the properties of detonations underwater, the animal's distance from the charge, the animal's location in the water column, and environmental factors such as water depth, water temperature, and bottom type. The net explosive weight accounts for the weight and the type of explosive material. Criteria for determining physiological impacts on sea turtles from impulsive sound are discussed in Section 3.5.3.1.3 (Acoustic and Explosive Thresholds and Criteria). The limited information on sea turtle behavioral responses to sounds is discussed in Section 3.5.3.1.2.5 (Behavioral Reactions).

Exposures that result in injuries such as nonlethal trauma and PTS may limit an animal's ability to find or obtain food, communicate with other animals, avoid predators, and interpret the environment around it. Impairment of these abilities can decrease an individual's chance of survival or impact its ability to successfully reproduce. Mortality of an animal will remove the animal entirely from the population as well as eliminate its future reproductive potential.

As discussed in Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift), the thresholds that were used to quantitatively predict onset of TTS and PTS for sea turtles were incorrectly lowered when developing sea turtle acoustic impact criteria based on cetacean data. Therefore, the predicted impacts are conservative (i.e., over-predicted).

There is some limited information on sea turtle behavioral responses to impulsive noise from airgun studies (Section 3.5.3.1.2.5, Behavioral Reactions) that can be used as a surrogate for explosive impact analysis. Any behavioral response to a single detonation would likely be a short-term startle response, if the animal responds at all. Multiple detonations over a short period may cause an animal to exhibit other behavioral reactions, such as interruption of feeding or avoiding the area.

3.5.3.1.8.1 Model-Predicted Impacts

The average ranges to impacts from explosions of different charge weights for each of the specific criteria (onset mortality, onset slight lung injury, onset slight gastrointestinal tract injury, PTS, and TTS) are shown in Table 3.5-9. Sea turtles within these ranges are predicted by the model to receive the associated impact. Information regarding the ranges to impacts is important not only for predicting acoustic impacts but also for verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level impacts, especially physiological impacts on sea turtles. Because propagation of the acoustic waves is affected by environmental factors at different locations and because some criteria are partially based on sea turtle mass, the range of impacts for particular criteria will vary.

Table 3.5-9: Ranges to Impacts from In-Water Explosions to Sea Turtles for Representative Sources

Criterion/ Predicted Impact[1]	Impact Predicted to Occur When Sea Turtle is at this Range (m) or Closer to a Detonation					
	Source Class E2 (0.5 lb. NEW)	Source Class E5 (10 lb. NEW)	Source Class E9 (250 lb. NEW)	Source Class E12 (1,000 lb. NEW)	Source Class E16 (14,000 lb. NEW)	Source Class E17 (58,000 lb. NEW)
Onset Mortality (1% Mortality)	12	47	137	204	2,483	3,963
Onset Slight Lung Injury	25	87	240	352	4,372	6,935
Onset Slight GI Tract Injury	25	71	147	274	765	1,249
Permanent Threshold Shift[2,3]	79	222	587	1,602	8,696	12,431
Temporary Threshold Shift[2,3]	178	598	1,711	3,615	19,192	26,992
Avoidance Behavior (for multiple impulses)	344	1,125	2,971	6,709	NA[4]	NA[4]

GI: gastrointestinal; lb.: pound; m: meters, NEW: net explosive weight
Ranges determined using REFMS, Navy's explosive propagation model.

1 Criteria for impacts are discussed in Section 3.5.3.1.3 (Acoustic and Explosive Thresholds and Criteria).

2 Modeling for sound exposure level-based impulsive criteria assumed explosive event durations of one second. Actual durations may be less, resulting in smaller ranges to impact.

3 PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

4 Source classes E16 and E17 are only used during ship shock trials. Each ship shock trial uses up to four detonations that are spaced about one week apart. Therefore, they are considered single impulses.

Based on the estimate of sound exposure level that could induce a sea turtle to exhibit avoidance behavior when exposed to repeated impulsive sounds (Section 3.5.3.1.3.12, Criteria for Behavioral Responses), the distance from an explosion at which a sea turtle may behaviorally react (e.g., avoid by moving farther away) can be estimated. These ranges are also shown in Table 3.5-9. If exposed to a single impulsive sound, a sea turtle is assumed to exhibit a brief startle reaction that would likely be biologically insignificant.

A region of cavitation may occur between a large underwater detonation and the water surface where the reflected shock wave causes a region of water tension. When this region collapses, a change in direction of the pressure wave can be created. During ship shock trial detonations, the cavitation region could extend beyond 1.1 nm at depths less than 30 m from the water surface (Craig and Rye 2008). Animals in this region could be killed or injured. Because the estimated cavitation range is less than the range to onset mortality for explosives used during ship shock trials (source class E16 and E17), any mortalities or injuries due to cavitation are accounted for within the impacts for onset mortality.

Table 3.5-10 through Table 3.5-16 present predicted impacts on sea turtles from explosive detonations estimated by the Navy Acoustic Effects Model, applying the impact threshold criteria shown in Table 3.5-3. The impact estimates for each alternative represent the total number of impacts and not necessarily the number of individuals exposed, as a single individual may be exposed multiple times over the course of a year.

Table 3.5-10: Annual Model-Predicted Impacts on Sea Turtles from Explosions for Training Activities under the No Action Alternative

Sea Turtle Species or Group	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	GI Tract Injury	Slight Lung Injury	Mortality
Hardshell Turtles[1]	23	3	0	1	1
Kemp's Ridley Turtle	14	1	0	0	0
Loggerhead Turtle	48	4	0	2	1
Leatherback Turtle	24	3	0	0	0

GI: gastrointestinal

[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.

[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

Table 3.5-11: Annual Model-Predicted Impacts on Sea Turtles from Explosions for Training Activities under Alternatives 1 and 2

Sea Turtle Species or Group	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	GI Tract Injury	Slight Lung Injury	Mortality
Hardshell Turtles[1]	85	11	1	3	2
Kemp's Ridley Turtle	39	2	0	1	1
Loggerhead Turtle	188	18	0	7	4
Leatherback Turtle	103	14	0	2	1

GI: gastrointestinal

[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

Table 3.5-12: Annual Model-Predicted Impacts on Sea Turtles from Explosions for Testing Activities under the No Action Alternative

Sea Turtle Species or Group	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	GI Tract Injury	Slight Lung Injury	Mortality
Hardshell Turtles[1]	10	1	0	1	0
Kemp's Ridley Turtle	1	0	0	0	0
Loggerhead Turtle	21	2	0	2	1
Leatherback Turtle	8	1	0	0	0

GI: gastrointestinal
[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

Table 3.5-13: Annual Model-Predicted Impacts on Sea Turtles from Explosions for Testing Activities under Alternative 1

Sea Turtle Species or Group	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	GI Tract Injury	Slight Lung Injury	Mortality
Hardshell Turtles[1]	45	6	0	3	4
Kemp's Ridley Turtle	5	0	0	0	2
Loggerhead Turtle	67	6	0	4	5
Leatherback Turtle	13	2	0	0	0

GI: gastrointestinal
Predicted impacts exclude those from ship shock trials.
[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

Table 3.5-14: Annual Model-Predicted Impacts on Sea Turtles from Explosions for Testing Activities under Alternative 2

Sea Turtle Species or Group	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	GI Tract Injury	Slight Lung Injury	Mortality
Hardshell Turtles[1]	55	7	0	4	5
Kemp's Ridley Turtle	6	0	0	0	2
Loggerhead Turtle	81	7	0	5	5
Leatherback Turtle	17	2	0	1	0

GI: gastrointestinal
Predicted impacts exclude those from ship shock trials.

[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

Table 3.5-15: Model-Predicted Impacts on Sea Turtles from Explosions during Aircraft Carrier Ship Shock Trial under Alternatives 1 and 2

Sea Turtle Species or Group	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	GI Tract Injury	Slight Lung Injury[3]	Mortality[3]
Hardshell Turtles[1]	74	2	0	215	40
Kemp's Ridley Turtle	5	0	0	16	2
Loggerhead Turtle	83	5	0	531	67
Leatherback Turtle	120	15	0	126	48

GI: gastrointestinal
Event would occur once per five-year period. Event uses up to four source class E17 charges (14,501–58,000 pounds [lb.] net explosive weight). Detonations are separated by about one week. Predicted impacts are the sum of impacts from the four detonations over one ship shock trial.
[1] The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.
[2] PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).
[3] For larger detonations, such as those that occur during ship shock trials, the range to onset of impacts based on impulse criteria (slight lung injury and mortality) may overtake a portion of the range to pressure and sound exposure level based impacts (temporary threshold shift, permanent threshold shift, and GI tract injury).

Table 3.5-16: Model-Predicted Impacts on Sea Turtles from Explosions during the Guided Missile Destroyer and Littoral Combat Ship Shock Trials Under Alternatives 1 and 2 (Per Single Full Ship Shock Trial Event)

Sea Turtle Species or Group	Temporary Threshold Shift[2]	Permanent Threshold Shift[2]	GI Tract Injury	Slight Lung Injury[3]	Mortality[3]
Hardshell Turtles[1]	38	1	0	23	4
Kemp's Ridley Turtle	3	0	0	1	0
Loggerhead Turtle	49	3	0	42	9
Leatherback Turtle	90	12	0	35	9

GI: gastrointestinal

Guided Missile Destroyer event would occur once per five-year period. Event uses up to four source class E16 charges (7,251–14,500 pound [lb.] net explosive weight). Detonations are separated by about one week. Predicted impacts are the sum of impacts from the four detonations over one ship shock trial.

Littoral Combat Ship event would occur twice per five-year period. Event uses up to four source class E16 charges (7,251–14,500 lb. net explosive weight). Detonations are separated by about one week. Predicted impacts are the sum of impacts from the four detonations over one ship shock trial.

1 The Hardshell Turtles category includes a combined density estimate for green, hawksbill, and all unidentified hardshell turtles. There is no separate density estimate for green or hawksbill sea turtles.

2 PTS and TTS impacts are over-estimated due to incorrect threshold weighting; see Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift).

3 For larger detonations, such as those that occur during ship shock trials, the range to onset of impacts based on impulse criteria (slight lung injury and mortality) may overtake a portion of the range to pressure and sound exposure level based impacts (temporary threshold shift, permanent threshold shift, and GI tract injury).

As discussed in Section 3.5.3.1.3.4 (Criteria for Hearing Loss – Temporary and Permanent Threshold Shift), the thresholds that were used to quantitatively predict onset of TTS and PTS for sea turtles were incorrectly lowered when developing sea turtle acoustic impact criteria based on cetacean data. Therefore, the predicted impacts shown above (PTS and TTS) are conservative (i.e., over-predicted). Additionally, some of the conservative assumptions made for the impact modeling and criteria may cause the impact predictions to be overestimated, as follows:

- Many explosions from munitions such as bombs and missiles actually explode upon impact with above-water targets. For this analysis, sources such as these were modeled as exploding at depths of 1 m, overestimating the amount of explosive and acoustic energy entering the water.
- For predicting TTS and PTS based on sound exposure level, the duration of an explosion is assumed to be one second. Actual detonation durations may be much shorter, so the actual sound exposure level at a particular distance may be lower.
- Mortality and slight lung injury criteria are based on juvenile turtle masses, which substantially increases that range to which these impacts are predicted to occur compared to the ranges that would be predicted using adult turtle masses.
- Animats are assumed to receive the full impulse of the initial positive pressure wave due to an explosion, although the impulse-based thresholds (onset mortality and onset slight lung injury) assume an impulse delivery time adjusted for animal size and depth. Therefore, these impacts are overestimated at farther distances and increased depths.
- The predicted acoustic impacts do not take into account mitigation measures implemented during many training and testing activities, such as exclusion zones around detonations. Smaller hatchling and early juvenile hardshell turtles tend to be near the surface and are often associated with *Sargassum*, which is subject to avoidance mitigation measures (Chapter 5.0, Standard Operating Procedures, Mitigation, and Monitoring).

Most training and testing activities using explosives occur every year. Results for ship shock trial testing activities shown below are presented separately from annual training and testing because these events would not occur annually.

3.5.3.1.8.2 No Action Alternative

Training Activities

Training activities under the No Action Alternative using explosives at or beneath the water surface would expose sea turtles to underwater impulsive sound. The largest source class used during training under the No Action Alternative would be E12 (651–1,000 pounds [lb.] net explosive weight). Explosives at or beneath the water surface would be used in all training range complexes, except typically none would be used in Key West Range Complex. The number of training events using explosives and their proposed locations are presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Model-predicted impacts on sea turtles due to explosives used in annually recurring training activities under the No Action Alternative are shown in Table 3.5-10. The results shown are the impacts on sea turtles predicted for one year of training. Under the No Action Alternative, the majority of predicted impacts are due to bombing exercises (air-to-surface) using source class E12 (651–1,000 lb. net explosive weight), missile exercises (air-to-surface) using source class E6 (11–20 lb. net explosive weight) and E10 (251–500 lb. net explosive weight), tracking exercise/torpedo exercise–Maritime Patrol Aircraft–sonobuoy using source class E4 (2.6–5 lb. net explosive weight), naval surface fire support–at sea using source class E5 (6–10 lb. net explosive weight), and gunnery exercise (air-to-surface)–rocket using source class E5 (6–10 lb. net explosive weight).

Most impacts are predicted to occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem, Southeast U.S. Continental Shelf Large Marine Ecosystem, and Gulf Stream Open Ocean Area. Sea turtles in the Gulf Stream Open Ocean Area would typically be post-hatchlings, juveniles, or migrating adults, while sea turtles in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems would typically be foraging adults and juveniles. Detonations would typically occur beyond about 3 nm from shore, minimizing impacts near nesting beaches. A small number of nearshore (within 3 nm) training events could occur in the Gulf of Mexico Large Marine Ecosystem, potentially exposing some sea turtles approaching nesting beaches to impulsive sounds over a short duration if the training occurred during nesting season.

A small number of sea turtles are predicted to be exposed to impulse levels associated with the onset of mortality (one loggerhead and one hardshell) and slight lung injury (two loggerheads and one hardshell) over any training year. Any injured sea turtles could suffer reduced fitness and long-term survival. Sea turtles that experience PTS (three leatherbacks, four loggerheads, one Kemp's ridley, and three hardshell) would have permanently reduced perception of sound within a limited frequency range. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, as the sea turtle hearing range is already limited. A long-term consequence could be an impact on an individual turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness; however, because most sounds are broadband, a reduction in sensitivity over a small portion of hearing range may not interfere with perception of most sounds. One hundred nine sea turtles are predicted to experience TTS, which would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure. PTS and TTS threshold criteria for sea turtles are conservatively based on criteria developed for mid-frequency marine mammals, so actual PTS and TTS impacts may be less than the predicted quantities.

Some sea turtles beyond the ranges of the above impacts may behaviorally react if they hear a detonation. Events consisting of single detonations, such as bombing and missile exercise, are expected to only elicit short-term startle reactions. If a sea turtle hears multiple detonations in a short period, such as during gunnery, firing, or sonobuoy exercises, it may react by avoiding the area. Any significant behavioral reactions could lead to a sea turtle expending energy and missing opportunities to secure resources. However, because most events would consist of a limited number of detonations and exposures would not occur over long durations, there would be an opportunity to recover from an incurred energetic cost.

Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected.

Under the No Action Alternative, training activities involving explosions would not occur in or near the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for green, hawksbill, and leatherback sea turtles. Training activities using explosives also would not occur in inland and nearshore waters used by American crocodiles and American alligators, nor would they occur in or near American crocodile critical habitat.

Pursuant to the ESA, use of explosives during training activities as described under the No Action Alternative:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles and ESA-listed American alligators; and*
- *will have no effect on sea turtle and American crocodile critical habitat.*

Testing Activities

Testing activities under the No Action Alternative using explosives at or beneath the water surface would expose sea turtles to underwater impulsive sound. The largest source class used during testing under the No Action Alternative is E14 (1,741–3,625 lb. net explosive weight). Explosives at or beneath the water surface would be used in all training range complexes, and within the Naval Undersea Warfare Center, Panama City Division Testing Range. The number of testing activities using explosives and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Model-predicted acoustic impacts on sea turtles due to explosions during annually recurring testing activities under the No Action Alternative are shown in Table 3.5-12 and include 1 loggerhead mortality; 2 loggerhead and 1 hardshell slight lung injuries; 1 leatherback, 2 loggerhead, and 1 hardshell PTS; and 40 TTS. The results shown are the impacts on sea turtles predicted for one year of testing. Under the No Action Alternative, the majority of predicted impacts are due to airborne projectile-based mine clearance system using source class E11 (501–650 lb. net explosive weight), anti-submarine warfare tracking test–Maritime Patrol Aircraft using source classes E3 (0.6–2.5 lb. net explosive weight) and E4 (2.6–5 lb. net explosive weight), and mine countermeasure/neutralization testing using source classes E4 (2.6-5 lb. net explosive weight) and E8 (61–100 lb. net explosive weight).

Most impacts are predicted to occur in Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Caribbean Sea Large Marine Ecosystems. Sea turtles in these areas would typically be adults and juveniles, not post-hatchlings. Although most detonations would occur beyond about 3 nm from shore, some testing activities may occur near shore (within 3 nm) in the Gulf of Mexico Large Marine Ecosystem, potentially exposing some sea turtles approaching nesting beaches to impulsive sounds over a short duration if the testing occurred during nesting season.

A small number of sea turtles are predicted to be exposed to impulse levels associated with the onset of mortality and slight lung injury over any testing year. Any injured sea turtles could suffer reduced fitness and long-term survival. Sea turtles that experience PTS would have permanently reduced perception of sound within a limited frequency range. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, as sea turtle hearing range is already limited. Impacts on an individual turtle's ability to sense biologically important sounds, such as predators or prey, could be a long-term consequence, reducing that animal's fitness; however, because most sounds are broadband, a reduction in sensitivity over a small portion of hearing range may not interfere with perception of most sounds. A larger number are predicted to experience TTS, which would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure. PTS and TTS threshold criteria for sea turtles are conservatively based on criteria developed for mid-frequency marine mammals, so actual PTS and TTS impacts may be less than predicted.

Some sea turtles beyond the ranges of the above impacts may behaviorally react if they hear a detonation. Events consisting of single detonations, such as mine detonation, are expected to only elicit short-term startle reactions. If a sea turtle hears multiple detonations in a short period, such as during gunnery activities, it may react by avoiding the area. Any significant behavioral reactions could lead to a sea turtle expending energy and missing opportunities to secure resources. However, because most events would consist of a limited number of detonations and exposures would not occur over long durations, there would be an opportunity to recover from an incurred energetic cost.

Because model-predicted impacts are conservative and most impacts would be short-term, potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected.

Under the No Action Alternative, testing activities involving explosions would not occur in or near the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for green, hawksbill, and leatherback sea turtles. Testing activities using explosives also would not occur in inland and nearshore waters used by American crocodiles and American alligators, nor would they occur in or near American crocodile critical habitat.

Pursuant to the ESA, use of explosives during testing activities as described under the No Action Alternative:

- *may affect and is likely to adversely affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on American crocodiles or American alligators; and*
- *will have no effect on sea turtle and American crocodile critical habitat.*

3.5.3.1.8.3 Alternative 1

Training Activities

Under Alternative 1, the number of explosive detonations at or beneath the water surface would increase compared to the No Action Alternative. The largest source class used during training under Alternative 1 would be E12 (651–1,000 lb. net explosive weight). Explosives at or beneath the water surface would be used in all training range complexes. The number of training activities using explosives and their proposed locations are presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Model-predicted impacts on sea turtles due to explosions during annually recurring training activities under Alternative 1 are shown in Table 3.5-11 and include 1 leatherback, 4 loggerhead, 1 Kemp's ridley, and 2 hardshell mortalities; 2 leatherback, 7 loggerhead, 1 Kemp's ridley, and 3 hardshell slight lung injuries; 1 hardshell GI tract injury; 14 leatherback, 18 loggerhead, 2 Kemp's ridley, and 11 hardshell PTS; and 415 TTS. The results shown are the impacts on sea turtles predicted for one year of training. Under Alternative 1, the majority of predicted impacts are due to bombing exercises (air-to-surface) using source class E12 (651–1,000 lb. net explosive weight), missile exercises (air-to-surface) using source class E6 (11–20 lb. net explosive weight) and E10 (251–500 lb. net explosive weight), tracking exercise/torpedo exercise–Maritime Patrol Aircraft–sonobuoy using source class E4 (2.6–5 lb. net explosive weight), mine neutralization-explosive ordnance disposal using source classes E5 through E8 (6–100 lb. net explosive weight), naval surface fire support–at sea using source class E5 (6–10 lb. net explosive weight), and gunnery exercise (air-to-surface)–rocket using source class E5 (6–10 lb. net explosive weight).

Most impacts are predicted to occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem, Southeast U.S. Continental Shelf Large Marine Ecosystem, and Gulf Stream Open Ocean Area. Sea turtles in the Gulf Stream Open Ocean Area would typically be post-hatchlings, juveniles, or migrating adults, while sea turtles in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems would typically be foraging adults and juveniles. Detonations would typically occur beyond about 3 nm from shore, minimizing impacts near nesting beaches. A small number of nearshore (within 3 nm) training events could occur in the Gulf of Mexico Large Marine Ecosystem, potentially exposing some sea turtles approaching nesting beaches to impulsive sounds over a short duration if the training occurred during nesting season.

Although the impacts on sea turtles are expected to increase under Alternative 1 compared to the No Action Alternative, the expected impacts on any individual sea turtle remain the same. For the reasons provided in Section 3.5.3.1.8.2 (No Action Alternative), potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Although a few individuals may experience long-term impacts, population-level impacts are not expected.

Under Alternative 1, training activities involving explosions would not occur in or near the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for green, hawksbill, and leatherback sea turtles. Training activities using explosives also would not occur in inland and nearshore waters used by American crocodiles and American alligators, nor would they occur in or near American crocodile critical habitat.

Pursuant to the ESA, use of explosives during training activities as described under Alternative 1:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on sea turtle and American crocodile critical habitat.*

Testing Activities

Under Alternative 1, the number of testing activities that use explosions at or beneath the water surface would increase over the No Action Alternative. The largest source class used during these annually recurring testing events would be E14 (1,741–3,625 lb. net explosive weight). Explosives at or beneath the water surface would be used during annually recurring testing in all training range complexes and within the Naval Surface Warfare Center, Panama City Division Testing Range. The most substantial increase in explosives use would occur during the ship shock trials of three platforms in the VACAPES or JAX Range Complexes: aircraft carrier (one event in five years), destroyer (one event in five years), and Littoral Combat Ship (two events in five years). Aircraft carrier full ship shock trials could use charges up to source class E17 (14,501–58,000 lb. net explosive weight). Destroyer and Littoral Combat Ship full ship shock trials could use charges up to source class E16 (7,251–14,500 lb. net explosive weight). The number of testing activities using explosives and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Model-predicted impacts on sea turtles due to explosions during annually recurring testing activities under Alternative 1 are shown in Table 3.5-13 and include 5 loggerhead, 2 Kemp's ridley, and 4 hardshell mortalities; 4 loggerhead and 3 hardshell slight lung injuries; 2 leatherback, 6 loggerhead, and 6 hardshell PTS; and 130 TTS. The results shown are the impacts on sea turtles predicted for one year of testing. Under Alternative 1, the majority of predicted impacts are due to sonobuoy lot acceptance testing using source classes E3 (0.6–2.5 lb. net explosive weight) and E4 (2.6–5 lb. net explosive weight), airborne projectile-based mine clearance system using source class E11 (501–650 lb. net explosive weight), anti-submarine warfare tracking test–Maritime Patrol Aircraft using source classes E3 (0.6–2.5 lb. net explosive weight) and E4 (2.6–5 lb. net explosive weight), and airborne mine neutralization system testing using source class E11 (501–650 lb. net explosive weight). Model-predicted impacts on sea turtles due to full ship shock trials under Alternative 1 are shown in Table 3.5-15 (Aircraft Carrier) and Table 3.5-16 (Guided Missile Destroyer and Littoral Combat Ship). These impacts are as follows for the aircraft carrier ship shock trial: 48 leatherback, 67 loggerhead, 2 Kemp's ridley, and 40 hardshell mortalities; 126 leatherback, 531 loggerhead, 16 Kemp's ridley, and 215 hardshell slight lung injuries; 15 leatherback, 5 loggerhead, and 2 hardshell PTS; and 282 TTS. These impacts are as follows for each guided missile destroyer or littoral combat ship shock trial: 9 leatherback, 9 loggerhead, and 4 hardshell mortalities; 35 leatherback, 42 loggerhead, 1 Kemp's ridley, and 23 hardshell slight lung injuries; 12 leatherback, 3 loggerhead, and 1 hardshell PTS; and 180 TTS.

Most impacts due to annually recurring testing activities are predicted to occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems, and in the Gulf Stream Open Ocean Area. A ship shock trial would introduce substantial impacts in the Southeast U.S. Continental Shelf and the Gulf Stream Open Ocean Area compared to the impacts caused by annual testing alone. Sea turtles in the Gulf Stream Open Ocean Area would typically be post-hatchlings, juveniles, or migrating adults, while sea turtles in the other large marine ecosystems would typically be adults and juveniles. A small number of nearshore (within 3 nm) testing events could occur in the Gulf of Mexico Large Marine Ecosystem, potentially exposing some sea turtles approaching nesting beaches to impulsive sounds over a short duration if the testing occurred during nesting season.

Although the impacts on sea turtles are expected to increase under Alternative 1 compared to the No Action Alternative, the expected impacts on any individual sea turtle remain the same. For the reasons provided in Section 3.5.3.1.8.2 (No Action Alternative), potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Although a few individuals may experience long-term impacts, population-level impacts are not expected.

Under Alternative 1, testing activities involving explosions would not occur in or near the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for green, hawksbill, and leatherback sea turtles. Testing activities using explosives also would not occur in inland and nearshore waters used by American crocodiles and American alligators, nor would they occur in or near American crocodile critical habitat.

Pursuant to the ESA, use of explosives during testing activities as described under Alternative 1:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on sea turtle and American crocodile critical habitat.*

3.5.3.1.8.4 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be identical as described in Section 3.5.3.1.8.3 (Alternative 1).

Pursuant to the ESA, use of explosives during training activities as described under Alternative 2:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on sea turtle and American crocodile critical habitat.*

Testing Activities

The number of annually recurring testing activities that use explosions under Alternative 2 would increase compared to the No Action Alternative. The most substantial increase in explosives use would occur during the ship shock trials of three platforms in the VACAPES or JAX Range Complexes: aircraft carrier (one event in five years), destroyer (one event in five years), and Littoral Combat Ship (two events in five years). Compared to Alternative 1, the number of detonations during annually recurring testing activities would increase by about 10 percent. The types of testing activities (both annually recurring activities and ship shock trials), source classes, and locations would be the same as those under Alternative 1.

Model-predicted impacts on sea turtles due to explosions during annually recurring testing activities under Alternative 2 are shown in Table 3.5-14. The results shown are the impacts on sea turtles predicted for one year of training, and include 5 loggerhead, 2 Kemp's ridley, and 5 hardshell mortalities; 1 leatherback, 5 loggerhead, and 4 hardshell slight lung injuries; 2 leatherback, 7 loggerhead, and 7 hardshell PTS; and 159 TTS. Model-predicted impacts on sea turtles due to full ship shock trials under Alternative 2 are the same as under Alternative 1 and are shown in Table 3.5-15 (Aircraft Carrier) and Table 3.5-16 (Guided Missile Destroyer and Littoral Combat Ship).

Although the impacts on sea turtles are expected to increase under Alternative 2 compared to the No Action Alternative, the expected impacts on any individual sea turtle remain the same. For the reasons provided in Section 3.5.3.1.8.2 (No Action Alternative), potential impacts are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Although a few individuals may experience long-term impacts, population-level impacts are not expected.

Under Alternative 2, testing activities involving explosions would not occur in or near the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for green, hawksbill, and leatherback sea turtles. Testing activities using explosives also would not occur in inland and nearshore waters used by American crocodiles and American alligators, nor would they occur in or near American crocodile critical habitat.

Pursuant to the ESA, use of explosives during testing activities as described under Alternative 2:

- *may affect and is likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on sea turtle and American crocodile critical habitat.*

3.5.3.1.9 Impacts from Pile Driving

Construction of an elevated causeway system, a temporary pier allowing offloading of supply ships, would require pile driving and pile removal during Joint Logistics Over-the-Shore training. A separate environmental assessment has been prepared to address impacts due to all activities that occur during Joint Logistics Over-the-Shore training, with the exception of impacts due to in-water noise generated during construction of the elevated causeway. This EIS/OEIS includes analysis of the impact of underwater noise generated by pile driving during elevated causeway construction to facilitate holistic analysis of impacts due to all underwater noise generated during training and testing in the Study Area.

Pile driving activities could include impact or vibratory pile driving and vibratory pile removal, which would produce impulsive and continuous sounds underwater. Sounds produced during pile driving are described in Section 3.0.5.3.1.3 (Pile Driving). Pile driving would occur only during training under Alternatives 1 and 2 during construction of the elevated causeway system. This activity would involve intermittent impact pile driving of 24-inch, uncapped, steel pipe piles over about two weeks at a rate of about eight piles per day, one pile at a time, for a total of approximately 100 piles. Each pile takes about 10 minutes to drive. When training events that use the elevated causeway system are complete, the structure would be removed. The piles would be removed using vibratory methods over seven to ten days. Crews can remove about 14 piles per day, each taking about six minutes to remove.

The duration of pile driving during installation and removal of piles is as follows:

Impact pile driving (approximately 100 piles):

- 100 piles/8 piles per day = 12.5 days
- 8 piles x 10 minutes impact driving per pile = 80 minutes per day
- Portion of day impact pile driving noise produced = 6 percent

Vibratory pile removal (approximately 100 piles):

- 100 piles/14 piles per day = 7.1 days
- 14 piles x 6 minutes vibratory removal per pile = 84 minutes per day
- Portion of day impact pile driving noise produced = 6 percent

Underwater noise effects from pile driving were modeled using a conservative estimate of geometric spreading loss of sound in shallow coastal waters. A spreading loss of 15*Log (radius) was used to estimate range (r) to the relevant pile driving criteria. A calculation of sea turtle exposures is then estimated by:

$$\text{Exposure estimate} = (n *(\pi r^2/2)) * \text{days of pile installation/removal}$$

Where:

n = density estimate used for each species/season
r = range to pile driving noise criteria threshold(s)
$\pi \approx 3.1415926$

The exposure estimate was calculated separately for the impact and the vibratory pile driving activities and combined to predict the total number of expected exposures. Three species of sea turtles (loggerhead, Kemp's ridley, and green), as well as a hardshell sea turtle group consisting of unidentified individuals of all hard shell sea turtle species, have density estimates occurring near the coastal pile driving locations.

Based on the calculation as described above, sound pressure levels associated with impact pile driving activities would be above the injury criteria threshold value (190 dB re 1µPa root mean square) only a short distance from the pile (approximately 10 m). Due to the small size of the potential injury zone and the low densities of sea turtles in the proposed project locations, no injurious exposures are predicted to occur due to impact pile driving activities associated with Navy training.

Impulses from an impact hammer are broadband and carry most of their energy in the lower frequencies. The impulses are within the hearing range of most sea turtles and can produce a shock wave that is transmitted to the sediment and water column (Reinhall and Dahl 2011). The impulses produced would be less than a second each, occur at a rate of 30–50 impulses per minute, and have a source level of around 190 dB re 1 µPa root mean square and 203 dB re 1 µPa peak at 10 meters from the pile (California Department of Transportation 2009).

Sound produced from a vibratory hammer is similar in frequency range to that of the impact hammer, except the source levels are much lower than the impact hammer. Since the vibrations typically oscillate at a rate of about 1,700 cycles per minute, the sound source is treated as a continuous sound source. The source level for vibratory removal of the size and type of piles that would be used during Navy training, assuming vibratory removal source levels are similar to vibratory driving source levels, would be around 170 dB re 1 µPa root mean square at 10 meters from the pile(California Department of Transportation 2009), less than the criteria threshold value for injury.

Despite the short duration of driving and removing a single pile, there is potential for auditory masking in sea turtles and some temporary physiological stress. In addition, sea turtles may exhibit behavioral responses to impact or vibratory pile driving, including short-term startle responses or avoidance of the area around the pile driving. Due to the presence of vessels and shore construction activity, sea turtles may avoid the areas around proposed construction before pile driving activities begin, decreasing any potential impacts.

3.5.3.1.9.1 No Action Alternative

Training Activities

Training activities under the No Action Alternative do not include pile driving.

Testing Activities

Testing activities under the No Action Alternative do not include pile driving.

3.5.3.1.9.2 Alternative 1

Training Activities

Pile driving would occur during construction and removal phases of the elevated causeway system near shore and within the surf zone at Joint Expeditionary Base Fort Story, Virginia Beach, Virginia; Joint Expeditionary Base Little Creek, Virginia Beach, Virginia; and Marine Corps Base Camp Lejeune, Jacksonville, North Carolina. Elevated causeway construction would occur once a year at one of the locations.

Sea turtles are present near the proposed elevated causeway construction areas as follows:

- The mouth of the Chesapeake Bay, near the Little Creek, Virginia and Ft. Story, Virginia locations, serves as an important developmental habitat for juvenile Kemp's ridley and loggerhead sea turtles during the summer months (Epperly et al. 1995c; Keinath et al. 1994; Morreale and Standora 2005). The presence of juvenile sea turtles in the Chesapeake Bay area peaks from May through October.

- Migrating or foraging green, hawksbill, or leatherback turtles may occur occasionally near the training areas, but are less likely to occur than loggerhead or Kemp's ridley turtles.

- The beaches at Little Creek, Virginia and Ft. Story, Virginia do not support regular sea turtle nesting; however, Onslow Beach, at the Camp Lejeune, North Carolina location, supports a small amount of loggerhead sea turtle nesting (67 nests laid in 2011 and 52 nests laid in 2012) (Seaturtle.org. 2013). Nesting has been recorded to occur as early as May and as late as early September.

Based on the sound fields produced during the impact installation and vibratory removal of 24-inch steel pipe piles, no injuries to sea turtles are predicted due to sound exposures during pile driving and removal activities associated with Navy training. However, sea turtles may briefly behaviorally respond to pile driving and removal, and may temporarily avoid the area immediately surrounding the pile driving. Because of the limited duration of pile driving activities and associated noise, any impacts are expected to be minor and short term. The likelihood that sea turtles would be disturbed if attempting to nest at Onslow beach, the only location that supports sea turtle nesting, is low because: (1) elevated causeway construction would not occur every year at Camp Lejeune, (2) sea turtle nesting only occurs over a four-month period, whereas elevated causeway construction could occur at any time during the year and may not overlap with nesting, and (3) pile driving and removal noise would be produced in the water for only about 80 minutes per day (about six percent of any day) over no more than about three weeks in total.

Proposed pile driving locations are not near sea turtle critical habitat in Puerto Rico and St. Croix, U.S. Virgin Islands. Pile driving and removal activities would not occur in the range of the American crocodile and would not occur near American crocodile critical habitat. American alligators are present at Camp Lejeune, North Carolina, but are not found in the area where pile driving and removal would occur.

Pursuant to the ESA, noise associated with pile driving during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, green, hawksbill, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on sea turtle or American crocodile critical habitat.*

Testing Activities

Testing activities under Alternative 1 do not include pile driving.

3.5.3.1.9.3 Alternative 2 (Preferred Alternative)

Training Activities

Under Alternative 2, there would be no change to pile driving installation and removal associated with Navy training activities as described in Alternative 1. Therefore, the effects under Alternative 2 would be the same as those previously described to sea turtles and crocodilians (American crocodile and American alligator) under Alternative 1.

Pursuant to the ESA, noise associated with pile driving during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, green, hawksbill, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on sea turtle and American crocodile critical habitat.*

Testing Activities

Testing activities under Alternative 2 do not include pile driving.

3.5.3.1.10 Impacts from Swimmer Defense Airguns

Airguns can introduce brief impulsive, broadband sounds into the marine environment. These sounds are likely within the audible range of most sea turtles. Sounds from airguns are capable of causing PTS or TTS (Section 3.5.3.1.2.2, Hearing Loss) or behavioral responses (Section 3.5.3.1.2.5, Behavioral Reactions). Single, small airguns would not cause direct trauma to sea turtles. Impulses from these small airguns lack the strong shock wave and rapid pressure increases of explosions that can cause primary blast injury or barotraumas (criteria for determining impacts on sea turtles from impulsive sound are discussed in Sections 3.5.3.1.3.2 Impulsive Sounds). The limited information on assessing sea turtle behavioral responses to impulsive sounds is discussed in Section 3.5.3.1.2.5 (Behavioral Reactions).

The behavioral response of sea turtles to the repeated firing of airguns has been studied for seismic survey airguns (e.g., oil and gas exploration) (Section 3.5.3.1.2.5, Behavioral Reactions). Sea turtles were shown to avoid higher level exposures or become agitated when exposed to higher level sources. However, the airguns proposed for use in Navy testing are smaller and fire a limited number of times, so reactions would likely be less than those observed in the studies.

3.5.3.1.10.1 Model-Predicted Impacts

Estimates of the number of sea turtles exposed to levels capable of causing these impacts were calculated using the Navy Acoustic Effects Model. For all testing activities using airguns, no PTS or TTS impacts were predicted.

3.5.3.1.10.2 No Action Alternative

<u>Training Activities</u>

Training activities under the No Action Alternative do not use airguns.

<u>Testing Activities</u>

Testing activities that impart underwater impulsive noise from airguns under the No Action Alternative include pierside integrated swimmer defense testing activities at pierside locations at Joint Expeditionary Base Little Creek, Virginia Beach, Virginia, and Newport, Rhode Island, as described in Table 2.8-3. Small airguns (60 cubic inches [$in.^3$]) would release a limited number of impulses in inland waters around Navy piers. These areas are industrialized, and the waterways carry a high volume of vessel traffic in addition to Navy vessels. These areas tend to have high ambient noise levels and limited numbers of sea turtles present due to the high levels of human activity. If sea turtles are present, they may alert, startle, avoid the immediate area, or not respond at all while the airgun is firing. Substantial behavioral impacts in these areas due to the proposed use of the swimmer defense airgun are unlikely. Impulses from swimmer defense airguns are not predicted to cause any PTS or TTS impacts on sea turtles. The increase in the number of sea turtles that may experience behavioral effects between the alternatives is small compared to the size of sea turtle populations and would not result in long-term consequences to the species.

Airgun use would not occur near sea turtle critical habitat. Use of airguns would occur outside the range where American crocodiles or American alligators are expected to be present and would not occur near American crocodile critical habitat.

Pursuant to the ESA, use of swimmer defense airguns during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

3.5.3.1.10.3 Alternative 1

Training Activities

Training activities under Alternative 1 do not use airguns.

Testing Activities

Testing activities that impart underwater impulsive noise from airguns under Alternative 1 include pierside integrated swimmer defense testing activities at Little Creek, Virginia Beach, Virginia and Newport, Rhode Island, as described in Table 2.8-3 and stationary source testing at Naval Surface Warfare Center, Panama City Division Testing Range. The types of impacts on sea turtles from exposures to airguns under Alternative 1 are the same as those described under the No Action Alternative. The increase in the number of sea turtles that may experience behavioral effects between the alternatives is small compared to the size of sea turtle populations and would not result in long-term consequences to the species.

Airguns use would not occur near sea turtle critical habitat. Use of airguns would occur outside the range where American crocodiles or American alligators are expected to be present and would not occur near American crocodile critical habitat.

Pursuant to the ESA, use of swimmer defense airguns during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

3.5.3.1.10.4 Alternative 2 (Preferred Alternative)

Training Activities

Training activities under Alternative 2 do not use airguns.

Testing Activities

Testing activities that impart underwater impulsive noise from airguns under Alternative 2 would increase compared to the No Action Alternative. Compared to Alternative 1, use of airguns would increase by about 10 percent, but locations and types of activities would be the same. The types of impacts on sea turtles from exposures to airguns under Alternative 2 are the same as those described under the No Action Alternative. The increase in the number of sea turtles that may experience behavioral effects between the alternatives is small compared to the size of sea turtle populations and would not result in long-term consequences to the species.

Airguns use would not occur near sea turtle critical habitat. Use of airguns would occur outside the range where American crocodiles or American alligators are expected to be present and would not occur near American crocodile critical habitat.

Pursuant to the ESA, use of swimmer defense airguns during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

3.5.3.1.11 Impacts from Weapons Firing, Launch, and Impact Noise

Sea turtles may be exposed to weapons firing and launch noise and sound from the impact of non-explosive munitions on the water's surface, as well as sound from in-air explosions near the water surface. The sounds produced by these activities are described in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Reactions by sea turtles to these specific stressors have not been recorded; however, sea turtles may be expected to react to weapons firing, launch, and non-explosive impact noise as they would other transient sounds (Section 3.5.3.1.2.5, Behavioral Reactions).

Sea turtles exposed to firing, launch, and non-explosive impact noise may exhibit brief startle reactions, avoidance, diving, or no reaction at all. Gunfire noise would typically consist of a series of impulsive sounds. Due to the short-term, transient nature of gunfire noise, animals may be exposed to multiple sounds but over a short time period. Launch noise would be transient and of short duration, lasting no more than a few seconds at any given location as a projectile travels. 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. Any launch noise transmitted into the water would likely be due only to launches from vessels. Most events would consist of single launches. Non-explosive bombs, missiles, and targets could impact the water with great force and produce a short duration impulsive sound underwater that would depend on the size, weight, and speed of the object at impact.

Animals that are within the area of any of these sounds would likely alert, startle, dive, or avoid the immediate area. An animal near the surface directly beneath the firing of a large gun may possibly experience sound exposure levels sufficient to cause a threshold shift; however, this potential impact may be unlikely if a sea turtle reacts to the presence of the vessel before a large gunfire event.

3.5.3.1.11.1 No Action Alternative

<u>Training Activities</u>

Training activities under the No Action Alternative include activities that produce in-water noise from weapons firing, launch, and non-explosive munitions impact with the water's surface. Activities could occur throughout the Study Area but would be concentrated in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, and in the Gulf Stream Open Ocean Area, mostly in the VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. The number of events and their proposed locations are described in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives).

An animal very near a launch or impact location could experience hearing impacts, although the potential for this effect has not been studied, any impact would only likely occur very close to the firing or impact point, and an animal may avoid vessel interactions before the firing of a gun. Sea turtles that experience PTS would have permanently reduced perception of sound within a limited frequency range. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, as the sea turtle hearing range is already limited. A long-term consequence could be an impact on an individual turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness. TTS would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure.

Any behavioral reactions would likely be short-term and consist of brief startle reactions, avoidance, or diving. Any significant behavioral reactions could lead to a sea turtle expending energy and missing opportunities to secure resources. However, because most events would consist of a limited number of firings or launches and would not occur over long durations, there would be an opportunity to recover from an incurred energetic cost.

Although some individuals may be impacted by activities that include weapons firing, launch, and non-explosive impact noise, population-level impacts are not expected.

These activities are unlikely to occur in the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for sea turtles. Additionally, any occurrence of these activities near these waters would have no effect on critical habitat since the noise associated with these activities would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill turtles or mating and nesting activities for the leatherback sea turtle.

These activities would not occur in areas where American crocodiles or the American alligator are expected to be present, nor would they occur near American crocodile critical habitat.

Pursuant to the ESA, noise associated with weapons firing, launch, and non-explosive impact during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

Testing Activities

Testing activities under the No Action Alternative include activities that produce in-water noise from weapons firing, launch, and non-explosive munitions impact with the water's surface. Activities could occur throughout the Study Area but would be concentrated in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, and in the Gulf Stream Open Ocean Area, in all of the range complexes, and at Naval Surface Warfare Center, Panama City Division Testing Range. The number of events and their proposed locations are described in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives).

An animal very near a launch or impact location could experience hearing impacts, although the potential for this effect has not been studied, any impact would only likely occur very close to the firing or impact point, and an animal may avoid vessel interactions before the firing of a gun. Sea turtles that experience PTS would have permanently reduced perception of sound within a limited frequency range. It is uncertain whether some permanent hearing loss over a part of a sea turtle's hearing range would have long-term consequences for that individual, as the sea turtle hearing range is already limited. A long-term consequence could be an impact on an individual turtle's ability to sense biologically important sounds, such as predators or prey, reducing that animal's fitness. TTS would result in short-term reduced perception of sound within a limited frequency range, lasting from minutes to days, depending on the exposure.

Any behavioral reactions would likely be short-term and consist of brief startle reactions, avoidance, or diving. Any significant behavioral reactions could lead to a sea turtle expending energy and missing opportunities to secure resources. However, because most events would consist of a limited number of firings or launches and would not occur over long durations, there would be an opportunity to recover from an incurred energetic cost. Although some individuals may be impacted by activities that include weapons firing, launch, and non-explosive impact noise, population-level impacts are not expected.

These activities are unlikely to occur in the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for sea turtles. Additionally, any occurrence of these activities near these waters would have no effect on critical habitat since the noise associated with these activities would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill turtles or mating and nesting activities for the leatherback sea turtle.

These activities would not occur in areas where American crocodiles or the American alligator are expected to be present, nor would they occur near American crocodile critical habitat.

Pursuant to the ESA, noise associated with weapons firing, launch, and non-explosive impact during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

3.5.3.1.11.2 Alternative 1

Training Activities

Training activities under Alternative 1 that produce in-water noise from weapons firing, launch, and non-explosive munitions impact with the water's surface would increase compared to the No Action Alternative. The locations and types of activities would be similar to those under the No Action Alternative. The number of events and their proposed locations are described in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives).

Although the impacts on sea turtles are expected to increase under Alternative 1 compared to the No Action Alternative, the expected impacts on any individual sea turtle would remain the same. For the reasons provided in Section 3.5.3.1.11.1 (No Action Alternative), although some individuals may be impacted by activities that include weapons firing, launch, and non-explosive impact, population-level impacts are not expected.

These activities are unlikely to occur in the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for sea turtles. Additionally, any occurrence of these activities near these waters would have no effect on critical habitat since the noise associated with these activities would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill turtles or mating and nesting activities for the leatherback sea turtle.

These activities would not occur in areas where American crocodiles or the American alligator are expected to be present, nor would they occur near American crocodile critical habitat.

Pursuant to the ESA, noise associated with weapons firing, launch, and non-explosive impact during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

Testing Activities

Testing activities under Alternative 1 that produce in-water noise from weapons firing, launch, and non-explosive munitions impact with the water's surface would increase compared to the No Action Alternative. Additional types of testing activities would be conducted under Alternative 1, notably addition of activities in the Caribbean Sea Large Marine Ecosystem at the Key West Range Complex. The number of events and their proposed locations are described in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives).

Although the impacts on sea turtles are expected to increase under Alternative 1 compared to the No Action Alternative, the expected impacts on any individual sea turtle would remain the same. For the reasons provided in Section 3.5.3.1.11.1 (No Action Alternative), although some individuals may be impacted by activities that include weapons firing, launch, and non-explosive impact, population-level impacts are not expected.

These activities are unlikely to occur in the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for sea turtles. Additionally, any occurrence of these activities near these waters would have no effect on critical habitat since the noise associated with these activities would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill turtles or mating and nesting activities for the leatherback sea turtle.

These activities would not occur in areas where American crocodiles or the American alligator are expected to be present, nor would they occur near American crocodile critical habitat.

Pursuant to the ESA, noise associated with weapons firing, launch, and non-explosive impact during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

3.5.3.1.11.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be identical as described in Section 3.5.3.1.11.2 (Alternative 1).

Pursuant to the ESA, noise associated with weapons firing, launch, and non-explosive impact during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

Testing Activities

Testing activities under Alternative 2 that produce in-water noise from weapons firing, launch, and non-explosive munitions impact with the water's surface would increase from the No Action Alternative. Locations and types of activities would be the same as those under Alternative 1, although the number of activities that produce in-water noise from weapons firing, launch, and non-explosive munitions impact with the water's surface would increase by about 10 percent. The number of events and their proposed locations are described in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives).

Although the impacts on sea turtles are expected to increase under Alternative 2 compared to the No Action Alternative, the expected impacts on any individual sea turtle would remain the same. For the reasons provided in Section 3.5.3.1.11.1 (No Action Alternative), although some individuals may be impacted by activities that include weapons firing, launch, and non-explosive impact, population-level impacts are not expected.

These activities are unlikely to occur in the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for sea turtles. Additionally, any occurrence of these activities near these waters would have no effect on critical habitat since the noise associated with these activities would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill turtles or mating and nesting activities for the leatherback sea turtle.

These activities would not occur in areas where American crocodiles or the American alligator are expected to be present, nor would they occur near American crocodile critical habitat.

Pursuant to the ESA, noise associated with weapons firing, launch, and non-explosive impact during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles;*
- *will have no effect on ESA-listed American crocodiles or ESA-listed American alligators; and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

3.5.3.1.12 Impacts from Vessel and Aircraft Noise

Vessel Noise

Vessel movements could occur throughout the Study Area, although some portions would have limited or no activity. Many ongoing and proposed training and testing activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels). Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to two weeks. Navy traffic is heaviest just offshore of Norfolk, Virginia, and Jacksonville, Florida, as well as along the coastal waters between the two ports (Mintz and Filadelfo 2011). Additionally, a variety of smaller craft are operated within the Study Area. Small craft types, sizes, and speeds vary. During training, speeds generally range from 10 to 14 knots; however, ships/craft can and will, on occasion, operate within the entire spectrum of their specific operational capabilities. A detailed description of vessel noise is provided in Section 3.0.5.3.1.6 (Vessel Noise).

Vessel noise has the potential to disturb sea turtles or crocodilians and potentially elicit an alerting, avoidance, or other behavioral reaction. Sea turtles are frequently exposed to vessels due to research, ecotourism, commercial and private vessel traffic, and government activities. It is likely that some sea turtles have habituated to vessel noise and may be more likely to respond to the sight of a vessel rather than the sound of a vessel, although both may play a role in prompting reactions (Hazel et al. 2007). The American crocodile and alligator are primarily freshwater and estuarine species, so their interactions with vessels are likely more limited, as noted by the South Florida Multi-Species Recovery Plan (U.S. Fish and Wildlife Service 1999), which indicated that recreational boating, including the use of jet skis, is limited in portions of American crocodile habitat but is likely to increase in the future. Little empirical research is available regarding the reactions of crocodilians to vessel noise. One study with the speckled caiman (*Caiman crocodilus*) in Costa Rica noted that these animals were frequently observed avoiding oncoming boats, a response that the authors considered was likely due in part to avoiding anthropogenic threats such as hunting as well as boat collisions (Grant and Lewis 2010). Generally, since crocodilians hear better at lower frequencies both in air and underwater (Higgs et al. 2002) and have a similar, if not slightly expanded, hearing range compared to sea turtles, their reactions to vessel noise may be similar. Any reactions are likely to be minor and short-term avoidance reactions, leading to no long-term consequences.

Auditory masking can occur due to vessel noise, potentially masking biologically important sounds for sea turtles (e.g., sounds of prey or predators) and crocodilians (e.g., sounds of prey, conspecifics for mating, or their young), which these species may rely upon. Potential for masking can vary depending on the ambient noise level within the environment (Section 3.0.4.5, Ambient Noise), the received level and frequency of the vessel noise, and the received level and frequency of the sound of biological interest. Masking by passing ships or other sound sources transiting the Study Area would be short-term, intermittent, and, therefore, unlikely to result in any substantial energetic 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 auditory masking for sea turtles, which could reduce an animal's ability to find prey, find mates, avoid predators, or navigate. However, Navy vessels make up a very small percentage of the overall traffic 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. While surface combatants and submarines may be detectable by sea turtles over ambient noise levels at distances of up to a few kilometers, any auditory masking would be minor and temporary. Other Navy ships and small craft 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 all sea turtle hearing. 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 for some large commercial vessels and outboard engines. Therefore, in the open ocean, noise from noncombatant Navy vessels may be detectable over ambient levels for tens of kilometers and some auditory masking is possible. In noisier inshore areas around Navy ports and ranges, vessel noise may be detectable above ambient for only several hundred meters. Some auditory masking to sea turtles is likely from noncombatant Navy vessels, especially in quieter, open-ocean environments.

Navy ports such as Mayport and Norfolk are heavily trafficked with private and commercial vessels in addition to naval vessels. Because Navy ships make up a small portion of the total ship traffic, even in the most concentrated port and inshore areas, proposed Navy vessel transits are unlikely to cause long-term abandonment of habitat by sea turtles.

Since the American crocodile and American alligator are primarily freshwater or estuarine species, their habitat likely only overlaps with a very small percentage of vessels activities that would occur during Navy training and testing in the nearshore waters. Because surface combatant ships and submarines require deeper waters to maneuver, they generally operate in the offshore marine environment. As a result, vessel noise from these sources would likely be undetectable to crocodilians over ambient levels due to the distance from the source. Smaller vessels that operate in the nearshore marine environment or in some estuarine habitats associated with ports and bays within the Study Area have more potential to overlap with habitat where the American crocodile or alligator may be present. In noisier inshore areas around Navy ports and ranges, vessel noise may be detectable above ambient for only several hundred meters. Since these training and testing activities would likely occur at the periphery of crocodilian habitat, any exposures would likely occur at a distance from source. Therefore, these animals would be expected to receive very low levels of exposure, if at all, because levels associated with these received signals would likely be indistinguishable from other background sources of noise from other anthropogenic (e.g., commercial or recreational boat traffic) or natural (e.g., waves, snapping shrimp) sources.

Aircraft Noise

Fixed- and rotary-wing aircraft are used for a variety of training and testing activities throughout the Study Area. Sea turtles may be exposed to aircraft-generated noise wherever aircraft overflights occur in the Study Area. Most of these sounds would be centered on airbases and fixed ranges within each range complex. 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). A severe but infrequent type of aircraft noise is the sonic boom, produced when the aircraft exceeds the speed of sound. A detailed description of aircraft noise as a stressor is provided in Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

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 area, as discussed in greater detail in Section 3.0.4 (Acoustic and Explosives Primer). Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. The maximum sound levels in water from aircraft overflight are about 150 dB re 1 µPa for an F/A-18 aircraft at 980 ft. altitude; about 125 dB re 1 µPa for an H-60 helicopter hovering at 50 ft.; and under ideal conditions, sonic booms from aircraft at 3,280 ft. could reach up to 178 dB re 1 µPa at the water's surface (Section 3.0.5.3.1.7, Aircraft Overflight Noise provides additional information on aircraft noise characteristics).

Sea turtles or crocodilians 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 sea turtle or crocodilians to fixed-wing or rotary-wing 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. Take-offs and landings from Navy vessels could startle sea turtles; however, these events only produce in-water noise at any given location for a brief period of time as the aircraft climbs to cruising altitude. Some sonic booms from aircraft could startle sea turtles, 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 unlikely, except for animals that are resident in inshore areas around Navy ports, on Navy fixed-ranges, or during major training exercises.

Low flight altitudes of helicopters during some activities, which often occur under 100 ft. altitude, may elicit a somewhat stronger behavioral response due to the proximity to the water; the slower airspeed and therefore longer exposure duration; and the downdraft created by the helicopter's rotor. Sea turtles would likely avoid the area under the helicopter. It is unlikely that an individual would be exposed repeatedly for long periods as these events typically transit open ocean areas within the Study Area.

Little is known about American crocodile or alligator responses to sounds from vessel transits and aircraft overflights. Their reactions to these sounds are expected to be similar to those anticipated for sea turtles.

3.5.3.1.12.1 No Action Alternative

Training Activities

Training activities under the No Action Alternative include noise from vessel movements and fixed- and rotary-wing aircraft overflights. Navy vessel and aircraft traffic associated with training could occur in all of the range complexes and throughout the Study Area while in transit. Certain portions of the Study Area such as areas near Navy ports and airfields, installations, and training ranges are used more heavily by vessels and aircraft than other portions of the Study Area, as described in further detail in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives), Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

Helicopters typically train closer to shore and at lower altitudes than fixed-wing aircraft. Sea turtles foraging in shallow waters or approaching nesting beaches may be exposed to in-water noise from helicopter overflights near Norfolk, Virginia; Camp Lejeune, North Carolina, and Jacksonville, Florida. Navy vessel traffic in the Study Area would be heavily concentrated near the Norfolk and Mayport Navy ports and within the VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. Vessel transits would be more concentrated near major ports at Norfolk, Virginia, and Jacksonville, Florida, as vessels transit to and from offshore training areas. The overlap between crocodilian habitats and activities that include vessel movement and fixed- and rotary-wing aircraft is expected to be more limited than for sea turtles. Small boats used for training activities in inshore waters associated with ports and bays have the most potential to overlap with these species, but even these activities are likely to occur on the periphery of their habitat because the American crocodile and alligator are primarily freshwater or estuarine species.

Sea turtles and crocodiles exposed to a passing Navy vessel or aircraft may not respond at all, or they may exhibit a short-term behavioral response such as avoidance or changing dive behavior. Short-term reactions to aircraft or vessels are not likely to disrupt major behavioral patterns or to result in serious injury to any sea turtles or crocodilians. Acoustic masking may occur due to vessel sounds, especially from noncombatant ships. Acoustic masking may prevent an animal from perceiving biologically relevant sounds during the period of exposure, potentially resulting in missed opportunities to obtain resources.

Long-term impacts due to the proposed activities are unlikely because the density of Navy ships in the Study Area is low overall and many Navy ships are designed to be as quiet as possible. Abandonment of habitat is unlikely due to proposed Navy activities because of the low overall density of Navy vessel and aircraft in the Study Area. No long-term consequences for individuals or the population would be expected.

Naval vessel transits and aircraft overflights are unlikely to occur in the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for sea turtles. Any occurrence of these activities near these waters would have no effect on critical habitat since they would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill turtles or mating and nesting activities for the leatherback sea turtle.

Under the No Action Alternative, there is low potential for overlap between vessel noise and fixed- and rotary-wing aircraft overflight noise associated with Navy training activities and critical habitat designated for the American crocodile. However, the occurrence of these activities in or near critical habitat would have no effect on the critical habitat because sounds from these activities would not result in the destruction or impairment of the habitat to support American crocodile populations. Therefore, there would be no effect from training activities associated with the No Action Alternative on critical habitat for the American crocodile.

Pursuant to the ESA, noise associated with vessels and aircraft during training as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed American crocodiles, American alligators, and ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

Testing Activities

Testing activities under the No Action Alternative include noise from vessel movements and fixed- and rotary-wing aircraft overflights. Navy vessel and aircraft traffic associated with testing could occur in all of the range complexes, at Naval Surface Warfare Center, Panama City Division Testing Range, Naval Undersea Warfare Center Division, Newport Testing Range, and throughout the Study Area while in transit. Certain portions of the Study Area, such as areas near Navy ports, installations, and testing ranges are used more heavily by vessels than other portions of the Study Area, as described in further detail in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives), Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

Helicopters typically fly closer to shore and at lower altitudes than fixed-wing aircraft. Sea turtles foraging in shallow waters or approaching nesting beaches may be exposed to in-water noise from helicopter overflights near Norfolk, Virginia; Camp Lejeune, North Carolina; Jacksonville, Florida; and Panama City, Florida. Navy vessel traffic in the Study Area would be heavily concentrated near the

Norfolk and Mayport Navy ports and within the range complexes. Vessel transits would be more concentrated near major ports at Norfolk, Virginia, and Jacksonville, Florida, as vessels transit to and from offshore testing areas. The overlap between crocodilian habitats and activities that include vessel movement and fixed- and rotary-wing aircraft is expected to be more limited than for sea turtles. Small boats used for training activities in inshore waters associated with ports and bays have the most potential to overlap with these species, but even these activities are likely to occur on the periphery of their habitat since the American crocodile and alligator are primarily freshwater or estuarine species.

Sea turtles and crocodiles exposed to a passing Navy vessel or aircraft may not respond at all, or they may exhibit a short-term behavioral response such as avoidance or changing dive behavior. Short-term reactions to aircraft or vessels are not likely to disrupt major behavioral patterns or to result in serious injury to any sea turtles or crocodilians. Acoustic masking may occur due to vessel sounds, especially from noncombatant ships. Acoustic masking may prevent an animal from perceiving biologically relevant sounds during the period of exposure, potentially resulting in missed opportunities to obtain resources.

Long-term impacts due to the proposed activities are unlikely because the density of Navy ships in the Study Area is low overall and many Navy ships are designed to be as quiet as possible. Abandonment of habitat is unlikely due to proposed Navy activities because of the low overall density of Navy vessel and aircraft in the Study Area. No long-term consequences for individuals or the population would be expected.

Naval vessel transits and aircraft overflights are unlikely to occur in the nearshore waters where critical habitat has been designated in Puerto Rico and St. Croix for sea turtles. Any occurrence of these activities near these waters would have no effect on critical habitat since they would not result in the destruction or impairment of the habitat to support the foraging and development of green and hawksbill turtles or mating and nesting activities for the leatherback sea turtle.

Under the No Action Alternative, there is low potential for overlap between vessel noise and fixed- and rotary-wing aircraft overflight noise and critical habitat designated for the American crocodile. However, the occurrence of these activities in or near critical habitat would have no effect on the critical habitat since sounds from these activities would not result in the destruction or impairment of the habitat to support American crocodile populations.

Pursuant to the ESA, noise associated with vessels and aircraft during testing as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed American crocodiles, American alligators, and ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

3.5.3.1.12.2 Alternative 1

Training Activities

Training activities proposed under Alternative 1 would increase vessel traffic and aircraft flight hours compared to the No Action Alternative, increasing overall amounts of aircraft and vessel noise. Certain portions of the Study Area such as areas near Navy ports and airfields, installations, and training ranges are used more heavily by vessels and aircraft than other portions of the Study Area, as described in further detail in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives), Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise). The types and locations of noise from vessels and aircraft would be similar to those under the No Action Alternative.

Although more sea turtles and crocodilians exposures to noise from vessels and aircraft could occur, predicted impacts from vessel or aircraft noise would not differ substantially from those under the No Action Alternative. Significant behavioral reactions by sea turtles or crocodiles due to passing vessel or aircraft noise are not expected. For the reasons stated in Section 3.5.3.1.12.1 (No Action Alternative), even though vessel and aircraft noise may cause short-term impacts, no long-term consequences for individuals or populations would be expected. Similarly, no impacts on critical habitats would occur.

Pursuant to the ESA, noise associated with vessels and aircraft during training as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed American crocodiles, American alligators, and ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

Testing Activities

Testing activities proposed under Alternative 1 would increase Navy vessel traffic and aircraft overflights compared to the No Action Alternative, increasing overall amounts of vessel and aircraft noise. In addition to activities under the No Action Alternative, additional ship trials would be conducted in the Northeast, VACAPES, JAX, and GOMEX Range Complexes, and activities that include the use of vessels would increase at the South Florida Ocean Measurement Facility Testing Range. New vessels proposed for testing under Alternative 1, such as the Littoral Combat Ship, the Joint High Speed Vessel, and the Expeditionary Fighting Vehicle, are all fast moving and designed to operate in nearshore waters. Overall noise levels may increase in these environments. The number of events and proposed locations are discussed in further detail in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives), Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

Although more sea turtles and crocodilians exposures to noise from vessels and aircraft could occur, predicted impacts from vessel or aircraft noise would not differ substantially from those under the No Action Alternative. Significant behavioral reactions by sea turtles, crocodiles, or alligators due to passing vessel or aircraft noise are not expected. For the reasons stated in Section 3.5.3.1.12.1 (No Action Alternative), even though vessel and aircraft noise may cause short-term impacts, no long-term consequences for individuals or populations would be expected. Similarly, no impacts on critical habitats would occur.

Pursuant to the ESA, noise associated with vessels and aircraft during testing as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed American crocodiles, American alligators, and ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

3.5.3.1.12.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities generating vessel noise under Alternative 2 are identical to training activities under Alternative 1; however, training activities generating aircraft noise would increase, specifically due to a 20 percent increase in air combat maneuver training in the Key West Range Complex. Other than the increase in noise generated by the increase in flight hours at Key West Range Complex, the number and location of training activities producing aircraft noise under Alternative 2 are identical to training activities under Alternative 1 (Section 3.5.3.1.12.2).

Although more sea turtles and crocodilian exposures to noise from vessels and aircraft overflights could occur, predicted impacts from vessel or aircraft noise would not differ substantially from those under the No Action Alternative. Significant behavioral reactions by sea turtles or crocodilians due to passing vessel or aircraft noise are not expected. For the reasons stated in Section 3.5.3.1.12.1 (No Action Alternative), even though vessel and aircraft noise may cause short-term impacts, no long-term consequences for individuals or populations would be expected. Similarly, no impacts on critical habitats would occur.

Pursuant to the ESA, noise associated with vessels and aircraft during training as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed American crocodiles, American alligators, and ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

Testing Activities

Testing activities proposed under Alternative 2 would increase Navy vessel traffic and aircraft overflights compared to the No Action Alternative, increasing overall amounts of vessel and aircraft noise. The types of activities and their locations would be similar to those under Alternative 1, although overall activities would increase by about 10 percent. The number of events and proposed locations are discussed in further detail in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives), Section 3.0.5.3.1.6 (Vessel Noise), and Section 3.0.5.3.1.7 (Aircraft Overflight Noise).

Although more sea turtle and crocodilian exposures to noise from vessels and aircraft could occur, predicted impacts from vessel or aircraft noise would not differ substantially from those under the No Action Alternative. Significant behavioral reactions by sea turtles or crocodiles due to passing vessel or aircraft noise are not expected. For the reasons stated in Section 3.5.3.1.12.1 (No Action Alternative), even though vessel and aircraft noise may cause short-term impacts, no long-term consequences for individuals or populations would be expected. Similarly, no impacts on critical habitats would occur.

Pursuant to the ESA, noise associated with vessels and aircraft during testing as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed American crocodiles, American alligators, and ESA-listed loggerhead, Kemp's ridley, hawksbill, green, and leatherback sea turtles and*
- *will have no effect on critical habitat designated for sea turtles or the American crocodile.*

3.5.3.2 Energy Stressors

This section analyzes the potential impacts of the various types of energy stressors that can occur during training and testing activities within the Study Area. This section includes analysis of the potential impacts from (1) electromagnetic devices and (2) high energy lasers.

3.5.3.2.1 Impacts from Electromagnetic Devices

Several different types of electromagnetic devices are used during training and testing activities. Section 3.0.5.3.2.1 (Electromagnetic Devices) discusses the types of activities that use electromagnetic devices, where they are used, and how many activities would occur under each alternative. Aspects of electromagnetic stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities).

Well over a century ago, electromagnetic fields were introduced into the marine environment within the Study Area by a wide variety of sources (e.g., power transmission cables), yet little is known about potential impacts from these sources. Studies on behavioral responses to magnetic fields have been conducted on green and loggerhead turtles. Loggerheads were found to be sensitive to field intensities ranging from 0.0047 to 4000 microteslas, and green turtles were found to be sensitive to field intensities from 29.3 to 200 microteslas (Normandeau et al. 2011). Since these data are the best available information, for this analysis, it is assumed 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 and Lohmann 1996b; 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 (Benhamou et al. 2011; Lohmann and Lohmann 1996b; 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 and Lohmann 1996a; Lohmann et al. 1997). For example, Lohmann and Lohmann (1996a) found that loggerhead hatchlings tested in a magnetic field of 52,000 nanoteslas swam eastward, and when the field was decreased to 43,000 nanoteslas, 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.

3.5.3.2.1.1 No Action Alternative

Training Activities

As discussed in Section 3.0.5.3.2.1 (Electromagnetic Devices), under the No Action Alternative, training activities involving electromagnetic devices occur in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as Gulf Stream Open Ocean Area–specifically within the VACAPES, Navy Cherry Point, and JAX Range Complexes. Use of electromagnetic devices is concentrated within the VACAPES Range Complex. All sea turtle species in the Study Area could potentially occur in these locations, and could potentially be exposed to the electromagnetic devices.

If in the immediate area (within about 650 ft. [200 m]) where electromagnetic devices are being used, sea turtles could deviate from their original movements, but the extent of this disturbance is likely to be inconsequential. 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 microtesla 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 to an individual's growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and are not expected to result in population-level impacts. The use of electromagnetic devices does not overlap with designated critical habitat for sea turtles.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, or loggerhead turtles and*
- *will have no effect on sea turtle critical habitat.*

Testing Activities

As discussed in Section 3.0.5.3.2.1 (Electromagnetic Devices), under the No Action Alternative, testing activities involving electromagnetic devices occur in the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems—specifically within the VACAPES Range Complex and Naval Surface Warfare Center, Panama City Division Testing Range. Activities using electromagnetic devices are concentrated within the Naval Surface Warfare Center, Panama City Division Testing Range. All sea turtle species in the Study Area could potentially occur in these locations and could potentially be exposed to the electromagnetic devices.

The electromagnetic devices used in testing 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 microtesla at 200 m from the source), (2) highly localized potential impact area, and (3) temporary duration of the activities (hours). Sea turtles may have a detectable response to electromagnetic exposure but would likely recover completely. Potential impacts of exposure to electromagnetic stressors are not expected to result in substantial changes to an individual's growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment and are not expected to result in population-level impacts. The use of electromagnetic devices does not overlap with designated critical habitat for sea turtles.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, or loggerhead turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.2.1.2 Alternative 1

Training Activities

As discussed in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, electromagnetic device use in the Study Area would increase by less than 2 percent compared to the No Action Alternative. Training activities involving electromagnetic devices would continue to occur in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area—specifically within the VACAPES, Navy Cherry Point, and JAX Range Complexes. In addition, activities would be introduced within the Gulf of Mexico Large Marine Ecosystem—specifically within the GOMEX Range Complex—as well as in any of the following bays or inland waters: Sandy Hook

Bay, Earle, New Jersey; lower Chesapeake Bay, Hampton Roads, Virginia; Beaufort Inlet Channel, Morehead City, North Carolina; Cape Fear River, Wilmington, North Carolina; St. Andrew Bay, Panama City, Florida; Sabine Lake, Beaumont, Texas; and Corpus Christi Bay, Corpus Christi, Texas. Electromagnetic device activities would remain concentrated within the VACAPES Range Complex. All sea turtle species in the Study Area could potentially occur in these locations and could potentially be exposed to the electromagnetic devices.

In comparison to the No Action Alternative, the increase in activities presented in Alternative 1 may slightly increase the risk of sea turtles being exposed to electromagnetic energy. Additionally, the introduction of activities in the GOMEX Range Complex and in the bays or inland waters specified above may expose additional sea turtles that would not have been encountered under the No Action Alternative. However, the differences in species overlap and potential impacts from electromagnetic devices on any exposed sea turtles during training activities would not be discernible from those described in Section 3.5.3.2.1.1 (No Action Alternative). For the reasons stated in Section 3.5.3.2.1.1 (No Action Alternative), the use of electromagnetic devices is not expected to cause more than a short-term behavioral disturbance to sea turtles or have any lasting impacts on their survival, growth, annual reproductive success, lifetime reproductive success (fitness), or species recruitment and are not expected to result in population-level impacts. The use of electromagnetic devices does not overlap with designated critical habitat for sea turtles.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; and*
- *will have no effect on sea turtle critical habitat.*

Testing Activities

As discussed in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, electromagnetic device use would increase by about 14 percent in the Study Area compared to the No Action Alternative. Testing activities involving electromagnetic devices would continue to occur in the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems—specifically within the VACAPES Range Complex and the Naval Surface Warfare Center, Panama City Division Testing Range. In addition, activities would be introduced within the Southeast U.S. Continental Shelf Large Marine Ecosystem, specifically within the South Florida Ocean Measurement Facility Testing Range, and anywhere within the Gulf of Mexico. Activities involving electromagnetic device use would remain concentrated within the Naval Surface Warfare Center, Panama City Division Testing Range. All sea turtle species in the Study Area could potentially occur in these locations and could potentially be exposed to the electromagnetic devices.

In comparison to the No Action Alternative, the 14 percent increase in activities presented in Alternative 1 may increase the risk of sea turtles being exposed to electromagnetic energy. Additionally, the introduction of activities in the VACAPES and JAX Range Complexes and within the South Florida Ocean Measurement Facility Testing Range may expose additional sea turtles that would not have been encountered under the No Action Alternative. However, the differences in species overlap and potential impacts from electromagnetic devices on any exposed sea turtles during testing activities would not be discernible from those described in Section 3.5.3.2.1.1 (No Action Alternative). For the reasons stated in Section 3.5.3.2.1.1 (No Action Alternative), the use of electromagnetic devices is not expected to cause more than a short-term behavioral disturbance to sea turtles or have lasting impacts on their survival, growth, recruitment, or reproduction. The use of electromagnetic devices does not overlap with designated critical habitat for sea turtles.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.2.1.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will be identical to those described in Section 3.5.3.2.1.2 (Alternative 1).

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; and*
- *will have no effect on sea turtle critical habitat.*

Testing Activities

As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 2, electromagnetic device use would increase by about 35 percent in the Study Area compared to the No Action Alternative but only increases by about 18 percent compared to Alternative 1. The location of testing activities and species potentially impacted under Alternative 2 are identical to those specified under Alternative 1. All sea turtle species in the Study Area could potentially occur in these locations and could potentially be exposed to the electromagnetic devices.

In comparison, the 35 percent increase in activities over the No Action Alternative and 18 percent increase in activities over Alternative 1 may increase the risk of sea turtles being exposed to electromagnetic energy under Alternative 2. However, the differences in species overlap and potential impacts from electromagnetic devices on any exposed sea turtles during testing activities would not be discernible from those described in Section 3.5.3.2.1.1 (No Action Alternative). For the reasons stated in Section 3.5.3.2.1.1 (No Action Alternative), the use of electromagnetic devices is not expected to cause more than a short-term behavioral disturbance to sea turtles or have any lasting impacts on their growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment and are not expected to result in population-level impacts. The use of electromagnetic devices does not overlap with designated critical habitat for sea turtles.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, leatherback, and loggerhead turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.2.2 Impacts from High Energy Lasers

This section analyzes the potential impacts of high energy lasers on sea turtles. As discussed in Section 3.0.5.3.2.2 (Lasers), high energy laser weapons are designed to disable targets, rendering them immobile. The primary concern is the potential for a sea turtle to be struck with the laser beam at or near the water's surface, which could result in injury or death. However, sea turtles would only be exposed to a laser if the beam missed the target. Should the laser strike the sea surface, a sea turtle at or near the surface could be exposed. The potential for exposure to a high energy laser beam decreases as the water depth increases, so a sea turtle on the surface is more likely to be exposed than a sea turtle that is submerged. Because the lasers are specifically designed to hit the target, any exposure of sea turtles to the laser beam is extremely unlikely.

The potential for a sea turtle to be directly struck by a high energy laser beam was evaluated using statistical probability modeling (Appendix G, Statistical Probability Model for Estimating Direct Strike Impact and Number of Potential Exposures) to estimate the probability of striking a sea turtle for a worst-case scenario. Input values include high energy laser use data (frequency and footprint), size of the testing area, sea turtle density data, and animal footprint. To estimate the potential to strike a sea turtle in a worst-case scenario, the impact area of all laser events was totaled over one year in the testing area for each alternative. Finally, the sea turtle species with the highest average seasonal density within the testing area was used.

Within the statistical probability model, the estimated potential for a sea turtle strike is influenced by the following assumptions:

- The model is two-dimensional and assumes that all sea turtles would be at or near the surface 100 percent of the time, when in fact, sea turtles spend a majority of their time submerged (Renaud and Carpenter 1994; Sasso and Witzell 2006).
- The model assumes the animal is stationary and does not account for any movement of the sea turtle or any potential avoidance of the testing activity.

Furthermore, standard operating procedures described in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) require the testing area to be cleared before high energy laser tests are conducted.

3.5.3.2.2.1 No Action Alternative

Under the No Action Alternative, no high energy lasers would be used during training or testing activities.

3.5.3.2.2.2 Alternative 1 and Alternative 2 (Preferred Alternative)

Training Activities

Under Alternative 1 and Alternative 2, no high energy lasers would be used during training activities.

Testing Activities

As discussed in Section 3.0.5.3.2.2 (Lasers), under Alternatives 1 and Alternative 2, high energy laser weapons tests would be introduced in the Northeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area—specifically within the VACAPES Range Complex. All species of sea turtles could occur within this portion of the Study Area and could potentially be exposed to high energy lasers.

The model results indicate that even for the species with the highest average seasonal density in the activity location (loggerhead sea turtle), the probability of a potential strike annually is 0.01 percent. Considering the assumptions in the model outlined above, there is a high level of certainty in the conclusion that a sea turtle would not be struck by a high energy laser. Furthermore, the high energy lasers used in testing activities under Alternative 2 are not expected to strike a sea turtle because sea turtles are likely to be submerged, and the potential for exposure to a high energy laser beam decreases as water depth increases. Potential impacts of exposure to high energy lasers 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. The use of high energy lasers does not overlap with designated critical habitat for sea turtles.

Pursuant to the ESA, the use of high energy lasers during testing activities as described under Alternatives 1 and 2:

- *will have no effect on ESA-listed green, hawksbill, Kemp's ridley, leatherback, or loggerhead turtles; and*
- *will have no effect on critical habitat.*

3.5.3.3 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. For a list of Navy activities that involve physical disturbance and strike stressors, refer to Section 3.0.5.3.3 (Physical Disturbance and Strike Stressors). The physical disturbance and strike stressors that may impact sea turtles include (1) vessels, (2) in-water devices, (3) military expended materials, and (4) seafloor devices. Sections 3.5.3.1.1 (Sound Producing and Explosive Activities) through 3.5.3.1.12 (Impacts from Vessel and Aircraft Noise) contain the analysis of the potential for disturbance of visual or acoustic cues.

The impact that a physical disturbance might have on 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 sea turtle. It is not known at what point or through what combination of stimuli (visual, acoustic, or detection in pressure changes) an animal becomes aware of a vessel or other potential physical disturbances before 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 are dependent 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. Given that the presentation of a physical disturbance should be rare and brief, the cost from the response is likely to be within the normal variation experienced by a sea turtle during 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.

3.5.3.3.1 Impacts from Vessels

Most training and testing activities under all alternatives involve some level of vessel activity. For a discussion of the types of activities that include the use of vessels, where they are used, and the speed and size characteristics of vessels used, see Section 3.0.5.3.3.1 (Vessels). Vessels include ships, submarines and boats ranging in size from small, 22-ft. (7-m) rigid-hull inflatable boats to aircraft carriers with lengths up to 1,092 ft. (333 m). Large Navy ships generally operate at speeds in the range of 10 to 15 knots, and submarines generally operate at speeds in the range of 8 to 13 knots. Small craft (for this discussion, less than 40 ft. [12 m] in length) have much more variable speeds (dependent on the mission). While these speeds are representative of most activities, some vessels need to operate outside these parameters. For example, to produce the required relative wind speed over the flight deck, an aircraft carrier vessel group engaged in flight operations must adjust its speed through the water accordingly. Conversely, there are other instances such as launch and recovery of a small rigid-hull inflatable boat; vessel boarding, search, and seizure training activities; or retrieval of a target when vessels will be dead in the water or moving slowly ahead to maintain steerage. There are a few specific activities, including high-speed tests of newly constructed vessels such as aircraft carriers, amphibious assault ships, and the Joint High Speed Vessel (which will operate at an average speed of 35 knots [64.8 km/h]), in which vessels operate at higher speeds. Up to 46 amphibious landings are planned only at Onslow Beach (Marine Corps Base Camp Lejeune), in the Navy Cherry Point Range Complex. Under Alternatives 1 and 2, up to six amphibious landings would also occur at Naval Station Mayport, specifically Seminole Beach.

Naval Station Mayport and Marine Corps Base Camp Lejeune have specific Integrated Natural Resource Management Plans for addressing sea turtles, and those plans include project avoidance and minimization actions that reduce threats from military activities to nesting sea turtles to a minimal level. Also, during the spring and summer, personnel implement an intensive sea turtle monitoring, nest relocation, and protection program so that amphibious landings and other training activities can be conducted without impacting protected species. Equally important, nest-free training areas are maintained by base personnel so that trainers do not have to work around active turtle nests. Therefore, with these measures in-place, amphibious assault activities would not cause any potential risk to adult sea turtles approaching the beach or to adults and hatchlings leaving the beach.

The number of Navy vessels in the Study Area at any given time varies and depends on local training or testing requirements. Most activities include either one or two vessels and may last from a few hours up to two weeks. Vessel movement as part of the Proposed Action would be widely dispersed throughout the Study Area but more concentrated in portions of the Study Area near ports, naval installations, range complexes, and testing ranges.

In an attempt to determine traffic patterns for Navy and non-Navy vessels, the Center for Naval Analysis conducted a review of historic data for commercial vessels, coastal shipping patterns, and Navy vessels (Mintz and Parker 2006). Commercial and non-Navy traffic, which included cargo vessels, bulk carriers, passenger vessels and oil tankers (all more than 65 ft. [20 m] long), was heaviest near the major shipping ports from the Gulf of Maine to southern Florida, as well as in specific international shipping lanes. Compared to coastal vessel activity, there was relatively little concentration of vessels in the other portions of the Study Area (Mintz and Parker 2006). Navy traffic was heaviest just offshore of Norfolk and Jacksonville, as well as along the coastal waters between the two ports.

Data from 2009 were analyzed by Mintz and Filadelfo (2011) and indicated that along the Atlantic U.S. Exclusive Economic Zone, Navy vessels accounted for slightly less than 6 percent of the total large-vessel traffic (from estimated hours) in that area. In the VACAPES and JAX Range Complexes where Navy vessel activity is concentrated, the Navy vessels accounted for 7 and 9 percent (respectively) of the total large vessel traffic. Barco et al. (2009) found that military vessels were 10.4 percent of the total vessels transiting (inbound and outbound) the Chesapeake Bay channel, an area of highly concentrated Navy activity because of the proximity of Naval Station Norfolk. Military vessels would account for an even smaller portion of total vessels if smaller vessels (less than 65 ft. [20 m] long) were included in these analyses.

Sea turtles can detect approaching vessels, likely by sight rather than by sound (Bartol and Ketten 2006; Hazel et al. 2007). Sea turtles seem to react more to slower moving vessels (2.2 knots) than to faster vessels (5.9 knots or greater). Vessel-related injuries to sea turtles are more likely to occur in areas with high boating traffic. For example, propeller wounds on loggerhead sea turtles are found often in southeast Florida, from Palm Beach County to Miami-Dade County, likely due to the prevalence of recreational boating in that region (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2007d). Although sea turtles likely hear and see approaching vessels, they may not be able to avoid all collisions. High-speed collisions with large objects can be fatal to sea turtles.

Minor strikes may cause temporary reversible impacts, such as diverting the turtle from its previous activity or causing minor injury. Major strikes are those that can cause permanent injury or death from bleeding/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 some time 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 et al. 1997), suggesting that not all vessel strikes are lethal. Conversely, 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.

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. Sea turtles spend most of their time submerged (Renaud and Carpenter 1994; Sasso and Witzell 2006). Leatherback turtles are more likely to feed at or near the surface in open ocean areas. Green, hawksbill, Kemp's ridley, and loggerhead 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. These species are distributed widely in all offshore portions of the Study Area.

To assess the risk or probability of a physical strike, the number, size, and speed of Navy vessels were considered, as well as the sensory capability of sea turtles to identify an approaching vessel. Because of the wide dispersal of large vessels in open ocean areas and the widespread, scattered distribution of turtles at sea, strikes during open-ocean transits of Navy vessels are unlikely. For very large vessels, the bow wave may even preclude a sea turtle strike. The probability of a strike is further reduced by Navy mitigation measures and standard operating procedures to avoid sea turtles (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). Smaller, faster vessels that operate in nearshore waters, where green, hawksbill, Kemp's ridley, and loggerhead sea turtles can be more densely concentrated, pose a greater risk (Chaloupka et al. 2008). Some vessels associated with training and testing can travel at high speeds, (see Section 3.0.5.3.3.1, Vessels) which increase the strike risk to sea turtles (Hazel et al. 2007). Most nearshore vessel movements through sea turtle foraging habitats occur near southern ports, such as Jacksonville and Panama City, Florida; and Corpus Christi, Texas. Vessels transiting in shallow waters to and from ports travel at slower speeds and pose less risk of strikes to sea turtles (Section 3.0.5.3.3.1, Vessels).

3.5.3.3.1.1 No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative)

Section 3.0.5.3.3.1 (Vessels) provides estimates of relative vessel use and location for each alternative. These estimates are based on the number of activities predicted for each alternative. While these estimates provide a prediction of use, actual Navy vessel usage is dependent upon military training requirements, deployment schedules, annual budgets, and other unpredictable factors. Training and testing concentrations are most dependent upon locations of Navy shore installations and established training and testing areas. Even with the introduction of the Undersea Warfare Training Range, these areas have not appreciably changed in the last decade and are not expected to change in the foreseeable future. Under Alternatives 1 and 2, the Study Area would be expanded from the No Action Alternative and the number of events may increase, but the concentration of vessel use and the manner in which the Navy trains and tests would remain consistent with the range of variability observed over the last decade. This is partly because multiple activities occur from the same vessel platform. Therefore, the increased number of activities estimated for Alternatives 1 and 2 is not expected to result in an increase in vessel use or transit. 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 strikes are expected to occur is likely to remain consistent with the previous decade or be reduced because of the implementation of mitigation measures as outlined in Chapter 5 Standard Operating Procedures, Mitigation, and Monitoring. The difference in activities from the No Action Alternative to Alternative 1 and Alternative 2, shown in Table 3.0-36, is not likely to change the probability of a vessel strike in any meaningful way.

Training Activities

As indicated in Section 3.0.5.3.3.1 (Vessels), the majority of the training activities under all alternatives involve vessels. This section provides a representative list of Navy vessel sizes and speeds and a graphic that illustrates the location for the Preferred Alternative and the relative use of vessels. These activities could be widely dispersed throughout the Study Area but would be more concentrated near naval ports, piers, and range areas. Navy training vessel traffic would especially be concentrated near Naval Station Norfolk in Norfolk, Virginia, in the Northeast U.S. Continental Shelf Large Marine Ecosystem, and Naval Station Mayport in Jacksonville, Florida, in the Southeast U.S. Continental Shelf Large Marine Ecosystem. There is no seasonal differentiation in Navy vessel use. Large vessel movement primarily occurs within the U.S. Exclusive Economic Zone, with most traffic flowing in a direct line between Naval Stations Norfolk and Jacksonville. There would be a higher likelihood of vessel strikes over the continental shelf portions than in the open-ocean portions of the Study Area because of the concentration of vessel movements in those areas. Support craft would be more concentrated in the coastal areas near naval installations, ports, and ranges. 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. These species are distributed widely in all offshore portions of the Study Area.

Given the concentration of Navy vessel movements near naval ports, piers and range areas, this training activity could overlap with green, Kemp's ridley, and loggerhead turtles occupying these waters. Hawksbill turtles occur in these areas, but less frequently than green, Kemp's ridley, and loggerhead turtles. Leatherback turtles are more likely to be farther offshore, in the open ocean, although in the summer they are known to forage in nearshore environments such as Pamlico Sound and the capes along North Carolina. Navy vessel activity during training exercises is less concentrated in the Gulf of Mexico, where all these species may occur, but Kemp's ridley and green turtles are more abundant.

Under the No Action Alternative, Alternative 1, and Alternative 2, exposure to vessels used in training activities may cause short-term disturbance to an individual turtle or, if struck, could lead to injury or death. As demonstrated by scars on all species of sea turtles, they cannot always avoid being struck; therefore, vessel strikes are a potential cause of mortality for these species. Although the likelihood of being struck is minimal, sea turtles that overlap with Navy exercises are more likely to encounter vessels. Potential impacts of exposure to vessels 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 vessels are not expected to result in population-level impacts. The use of vessels does not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, vessel use during training activities as described under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect and is likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, leatherback or loggerhead turtles; and*
- *will have no effect on sea turtle critical habitat.*

Testing Activities

As indicated in Section 3.0.5.3.3.1 (Vessels), most testing activities involve the use of vessels. However, the number of vessels used for testing activities is comparatively lower than the number of vessels used for training (less than 10 percent). In addition, testing often occurs jointly with training, so it is likely that the testing activity would occur on a training vessel. Vessel movement 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 the testing ranges off the northeast United States, off south Florida, and in the Gulf of Mexico. There would be a higher likelihood of vessel strikes over the continental shelf portions of the Study Area because of the concentration of vessel movement there.

Propulsion testing activities, also referred to as high-speed vessel trials, occur infrequently but pose a higher strike risk because of the high speeds at which the vessels need to transit to complete the testing activity. These activities would most often occur in the Gulf of Mexico Large Marine Ecosystem in the Gulf of Mexico but may occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem in the Northeast Range Complexes, the Gulf Stream Open Ocean Area, and the North Atlantic Gyre Open Ocean Area in the VACAPES and JAX Range Complexes. However, there are just a few of these activities proposed per year, so the increased risk is nominal compared to all vessel use in the Proposed Action. 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. These species are distributed widely in all offshore portions of the Study Area.

Given the concentration of Navy vessel movements near naval ports, piers, and range areas; over the continental shelf portions of the Study Area; and in the Gulf of Mexico, testing activity could overlap with any sea turtle species.

Under the No Action Alternative, Alternative 1, and Alternative 2, exposure to vessels used in testing activities may cause short-term disturbance to an individual turtle, or if struck, could lead to injury or death. As demonstrated by scars on all species of sea turtles, they cannot always avoid being struck; therefore, vessel strikes are a potential cause of mortality for these species. Although the likelihood of being struck is minimal, sea turtles that overlap with Navy exercises are more likely to encounter vessels. Potential impacts of exposure to vessels 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 vessels are not expected to result in population-level impacts. The use of vessels does not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, vessel use during testing activities as described under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect and is likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, leatherback or loggerhead turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.3.2 Impacts from In-Water Devices

In-water devices are generally smaller (several inches to 111 ft. [34 m]) than most Navy vessels. Section 3.0.5.3.3.2 (In-Water Devices) discusses the types of activities that use in-water devices, where they are used, and how many activities would occur under each alternative. This section also includes a list of representative types, sizes, and speeds of Navy in-water devices used in the Study Area.

Devices that pose the greatest collision risk to sea turtles are those that are towed or operated at high speeds, including remotely operated high-speed targets and mine warfare systems. Devices that move slowly through the water column have a very limited potential to strike a sea turtle because sea turtles in the water could avoid a slow-moving object.

3.5.3.3.2.1 No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative)

Section 3.0.5.3.3.2 (In-Water Devices) provides estimates of relative in-water device use and locations for each of the alternatives. These estimates are based on the number of activities predicted for each alternative. While these estimates provide a prediction of use, actual Navy in-water device usage is dependent upon military training requirements, deployment schedules, annual budgets and other unpredictable factors. Training and testing concentrations are most dependent upon locations of Navy shore installations and established training and testing areas. Even with the introduction of the Undersea Warfare Training Range, these areas have not appreciably changed in the last decade and are not expected to change in the foreseeable future. Under Alternatives 1 and 2, the Study Area would be expanded from the No Action Alternative and the number of events may increase, but the concentration of in-water device use and the manner in which the Navy trains and tests would remain consistent with the range of variability observed over the last decade. This is partly because multiple activities occur from the same vessel platform. Therefore, the increased number of activities estimated for Alternatives 1 and 2 is not expected to result in an increase in in-water device use or transit. Consequently, the Navy does not foresee any appreciable changes in the levels, frequency, or locations where in-water devices have been used over the last decade and therefore the level at which strikes are expected to occur is likely to remain consistent with the previous decade or be reduced because of the implementation of mitigation measures as outlined in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring. The difference in activities from the No Action Alternative to Alternative 1 and Alternative 2, shown in Table 3.0-36, is not likely to change the probability of an in-water device strike in any meaningful way.

Training Activities

As discussed in Section 3.0.5.3.3.2 (In-Water Devices), training activities involving in-water devices occur in the Gulf of Mexico, Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems, and the

Gulf Stream Open Ocean Area—specifically within the VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. Use of in-water devices is concentrated within the VACAPES Range Complex. The number of activities that employ in-water devices increases by 66 percent under Alternative 1 and Alternative 2 compared to the No Action Alternative. 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. These species are distributed widely in all offshore portions of the Study Area.

Under the No Action Alternative, Alternative 1, and Alternative 2, exposure to in-water devices used in training activities may cause short-term disturbance to an individual turtle, or if struck, could lead to injury or death. However, these devices move slowly through the water column and have very limited potential to strike a sea turtle because sea turtles in the water could avoid a slow-moving object. Potential impacts of exposure to in-water devices 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 vessels are not expected to result in population-level impacts. The use of in-water devices does not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of in-water devices during training activities as described under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, leatherback or loggerhead turtles; and*
- *will have no effect on sea turtle critical habitat.*

Testing Activities

As discussed in Section 3.0.5.3.3.2 (In-Water Devices), testing activities involving in-water devices occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem, Southeast U.S. Continental Shelf Large Marine Ecosystem, and the Gulf of Mexico Large Marine Ecosystem—specifically within the Northeast Range Complexes; Naval Undersea Warfare Center Division, Newport Testing Range; VACAPES Range Complex; JAX Range Complex; South Florida Ocean Measurement Facility Testing Range (Alternatives 1 and 2 only); and Naval Surface Warfare Center, Panama City Division Testing Range—although some activities could occur anywhere in the Study Area. Use of in-water devices is concentrated within the VACAPES Range Complex; Naval Undersea Warfare Center Division, Newport Testing Range; and Naval Surface Warfare Center, Panama City Division Testing Range. 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. These species are distributed widely in all off-shore portions of the Study Area.

Under the No Action Alternative, Alternative 1, and Alternative 2, exposure to in-water devices used in testing activities may cause short-term disturbance to an individual turtle, or if struck, could lead to injury or death. However, these devices move slowly through the water column and have very limited potential to strike a sea turtle because sea turtles in the water could avoid a slow-moving object. Potential impacts of exposure to in-water devices 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 in-water devices are not expected to result in population-level impacts. The use of in-water devices does not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of in-water devices during testing activities as described under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, leatherback or loggerhead turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.3.3 Impacts from Military Expended Materials

This section analyzes the strike potential to sea turtles from the following categories of military expended materials (1) non-explosive practice munitions, (2) fragments from high-explosive munitions and (3) expended materials other than munitions, such as sonobuoys and expendable targets. For a discussion of the types of activities that use military expended materials, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.3 (Military Expended Material Strikes). The analysis of all potential impacts of military expended materials on critical habitat is included in this section.

While disturbance or strike from an item as it falls through the water column is possible, it is not very likely because the objects generally sink through the water slowly and can be avoided by most sea turtles. 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 sea turtles to be struck by military expended materials was evaluated using statistical probability modeling to estimate the likelihood. Specific details of the modeling approach including model selection and calculation methods can be found in Appendix G, (Statistical Probability Model for Estimating Direct Strike Impact and Number of Potential Exposures) which estimates the highest probability of striking a sea turtle. Input values include munitions data (frequency, footprint, and type), size of the training and testing area, sea turtle density data, and size of the animal (area of potential impact). To estimate the potential to strike a sea turtle, the highest probability of a strike was calculated by totaling the impact area of all bombs and projectiles over one year in the training or testing area for each alternative with the highest projected use (concentration of military expended materials), and using the sea turtle species with the highest average seasonal density within the activity at each location. These highest estimates would then provide a point of comparison for all other areas and species. The areas with the greatest concentration of expended materials are expected to be the Northeast U.S. Continental Shelf Large Marine Ecosystem, the Southeast U.S. Continental Shelf Large Marine Ecosystem, and the Gulf Stream Open Ocean Area (specifically within the VACAPES and JAX Range Complexes). Section 3.0.5.3.3 (Physical Disturbance and Strike Stressors) provides estimates of expended materials throughout the Study Area. The analysis of the potential for a sea turtle strike is influenced by the following assumptions:

- The model is two-dimensional and assumes that all sea turtles would be at or near the surface 100 percent of the time, when in fact, sea turtles spend most of their time submerged (Renaud and Carpenter 1994; Sasso and Witzell 2006).
- 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 model does not account for the ability of Navy observers to see and avoid sea turtles. The model also does not account for 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 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 below because those activities happen with much lower frequency. Fragments may include metallic fragments from the exploded target as well as from the exploded munitions.

The probability of a strike is further reduced by Navy mitigation measures and standard operating procedures to avoid sea turtles (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

There is a remote possibility that an individual turtle at or near the surface may be struck directly if it is 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. While any species of sea turtle may move through the open ocean, most will only surface intermittently. Sea turtles are generally at the surface for short periods and spend most of their time submerged (Renaud and Carpenter 1994; Sasso and Witzell 2006). The leatherback 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. Furthermore, projectiles are aimed at targets, which will absorb the impact of the projectile.

3.5.3.3.3.1 No Action Alternative

Training Activities

Tables located in Section 3.0.5.3.3.3 (Military Expended Material Strikes) list the activities that involve military expended materials (e.g., bombs, projectiles, missiles, and rockets), most of which are small- and medium-caliber projectiles. This section also provides details of the number and location of military expended materials used within the Study Area. As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under the No Action Alternative, the areas with the greatest amount of expended materials are expected to be the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems and the Gulf Stream Open Ocean Area—specifically within the Northeast, VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes. Activities using military expended materials are concentrated within the VACAPES and JAX Range Complexes. 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. These species are distributed widely in all off-shore portions of the Study Area.

Under the No Action Alternative, exposure to military expended materials used in training activities may cause short-term disturbance to an individual turtle, or if struck, could lead to injury or death. However, sea turtles are generally at the surface only for short periods and spend most of their time submerged, so the likelihood of being struck by military expended material is very low. Projectiles are aimed at targets, which will absorb the impact of the projectile. The model results presented in Table 3.5-17 indicate a high level of certainty that sea turtles would not be struck by military expended materials during training activities. Potential impacts of exposure to military expended materials 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 military expended materials are not expected to result in population-level impacts. The use of military expended materials does not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of military expended materials during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

Table 3.5-17: Probability of a Military Expended Materials Strike for a Representative Sea Turtle Species by Area and Alternative

Northeast United States Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area						
Virginia Capes Range Complex						
Species	Training			Testing		
	No Action	Alternative 1	Alternative 2	No Action	Alternative 1	Alternative 2
Loggerhead Turtle	0.74%	1.78%	1.78%	1.51%	2.29%	2.42%
Southeast United States Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area						
Jacksonville Range Complex						
Species	**Training**			**Testing**		
	No Action	**Alternative 1**	**Alternative 2**	**No Action**	**Alternative 1**	**Alternative 2**
Loggerhead Turtle	0.50%	1.04%	1.04%	0.17%	0.28%	0.31%

Testing Activities

Tables located in Section 3.0.5.3.3.3 (Military Expended Material Strikes) list the activities that involve military expended materials (e.g., bombs, projectiles, missiles, and rockets), most of which are small- and medium-caliber projectiles. This section also provides details of the number and location of military expended materials used within the Study Area. As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under the No Action Alternative, the areas with the greatest amount of expended materials are expected to be the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems and the Gulf Stream Open Ocean Area—specifically within the Naval Surface Warfare Center Panama City Division Testing Range, the Northeast, VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes—and in the Other AFTT Areas while vessels are in transit. Activities using military expended materials are concentrated within the VACAPES Range Complex. 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. These species are distributed widely in all off-shore portions of the Study Area.

Under the No Action Alternative, exposure to military expended materials used in testing activities may cause short-term disturbance to an individual turtle, or if struck, could lead to injury or death. However, sea turtles are generally at the surface only for short periods and spend most of their time submerged, so the likelihood of being struck by a projectile is very low. Projectiles are aimed at targets, which will absorb the impact of the projectile. The model results presented in Table 3.5-17 indicate a high level of certainty that sea turtles would not be struck by military expended materials during testing activities. Potential impacts of exposure to military expended materials 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 military expended materials are not expected to result in population-level impacts. The use of military expended materials does not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of military expended materials during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.3.3.2 Alternative 1

Training Activities

Tables located in Section 3.0.5.3.3.3 (Military Expended Material Strikes) list the activities that involve military expended materials (e.g., bombs, projectiles, missiles, and rockets), most of which are small- and medium-caliber projectiles. This section also provides details on the number and location of military expended materials used within the Study Area. As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under Alternative 1, the total amount of military expended materials is more than three times the amount expended in the No Action Alternative. The locations of activities and types of military expended materials under Alternative 1 would be the same as the No Action Alternative, with the addition of military expended materials associated with activities in Other AFTT Areas while vessels are in transit. Activities using military expended materials are concentrated within the VACAPES, Navy Cherry Point, and JAX Range Complexes. 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. These species are distributed widely in all offshore portions of the Study Area.

Under Alternative 1, exposure to military expended materials used in training activities may cause short-term disturbance to an individual turtle, or if struck, could lead to injury or death. However, sea turtles are generally at the surface only for short periods and spend most of their time submerged, so the likelihood of being struck by a military expended material is very low. Projectiles are aimed at targets, which will absorb the impact of the projectile. The model results presented in Table 3.5-17 indicate a high level of certainty that sea turtles would not be struck by military expended materials during training activities. Potential impacts of exposure to military expended materials 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 military expended materials are not expected to result in population-level impacts. Military expended materials would not overlap any designated sea turtle critical habitat.

Pursuant to the ESA, the use of military expended materials during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

Testing Activities

Tables located in Section 3.0.5.3.3.3 (Military Expended Material Strikes) list the activities that involve military expended materials (e.g., bombs, projectiles, missiles, and rockets), most of which are small-and medium-caliber projectiles. This section also provides details of the number and location of military expended materials used within the Study Area. As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under Alternative 1, the total amount of military expended materials is nearly four times the amount expended in the No Action Alternative. The activities and type of military expended materials under Alternative 1 would be expended in the same geographic locations as the No Action Alternative. Activities using military expended materials are concentrated within the VACAPES Range Complex. Military expended materials would typically be of the same type listed under the No Action Alternative. 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. These species are distributed widely in all offshore portions of the Study Area.

Under Alternative 1, exposure to military expended materials used in testing activities may cause short-term disturbance to an individual turtle, or, if struck, could lead to injury or death. However, sea turtles are generally at the surface only for short periods and spend most of their time submerged, so the likelihood of being struck by a military expended material is very low. Projectiles are aimed at targets, which will absorb the impact of the projectile. The model results presented in Table 3.5-17 indicate a high level of certainty that sea turtles would not be struck by military expended materials during testing activities. Potential impacts of exposure to military expended materials 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 military expended materials are not expected to result in population-level impacts. Military expended materials would not overlap any designated sea turtle critical habitat.

Pursuant to the ESA, the use of military expended materials during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.3.3.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and locations of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be as described in Section 3.5.3.3.3.2 (Alternative 1).

Testing Activities

Tables in Section 3.0.5.3.3.3 (Military Expended Material Strikes) list the activities that involve military expended materials (e.g., bombs, projectiles, missiles, and rockets), most of which are small- and medium-caliber projectiles. This section also provides details of the number and location of military expended materials used within the Study Area. As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under Alternative 2, the total amount of military expended materials is more than four times the amount expended in the No Action Alternative but only increases by 11 percent compared to Alternative 1. The activities and type of military expended materials under Alternative 2 would be expended in the same geographic locations as the No Action Alternative. Activities using military expended materials are concentrated within the VACAPES Range Complex. Military expended materials would typically be of the same type listed under the No Action Alternative. 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. These species are distributed widely in all offshore portions of the Study Area.

Under Alternative 2, exposure to military expended materials used in testing activities may cause short-term disturbance to an individual turtle, or, if struck, could lead to injury or death. However, sea turtles are generally at the surface only for short periods and spend most of their time submerged, so the likelihood of being struck by a military expended material is very low. Projectiles are aimed at targets, which will absorb the impact of the projectile. The model results presented in Table 3.5-17 indicate a high level of certainty that sea turtles would not be struck by military expended materials during testing activities. Potential impacts of exposure to military expended materials 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 military expended materials are not expected to result in population-level impacts. Military expended materials would not overlap any designated sea turtle critical habitat.

Pursuant to the ESA, the use of military expended materials during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.3.4 Impacts from Seafloor Devices

Section 3.0.5.3.3.4 (Seafloor Devices) discusses the types of activities that use seafloor devices, where they are used, and how many activities would occur under each alternative. These 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 recovered (not expended).

As discussed in Section 3.5.3.3.3 (Impacts from Military Expended Materials), objects falling through the water column will slow as they sink toward the bottom and could be avoided by most 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 is considered in the military expended material strike analysis (Section 3.5.3.3.3, Impacts from Military Expended Materials).

3.5.3.3.4.1 No Action Alternative

<u>Training Activities</u>

Section 3.0.5.3.3.4 (Seafloor Devices) lists the number and locations where seafloor devices are used. As discussed in Section 3.0.5.3.3.4 (Seafloor Devices), under the No Action Alternative, seafloor devices occur in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as Gulf Stream Open Ocean Area—specifically within the VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. 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. These species are distributed widely in all offshore portions of the Study Area.

Under the No Action Alternative, exposure to seafloor devices used in training activities may cause short-term disturbance to an individual turtle or, if struck, could lead to injury or death. However, objects falling through the water column will slow as they sink toward the bottom and could be avoided by most sea turtles. Potential impacts of exposure to seafloor devices 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 seafloor devices are not expected to result in population-level impacts. Seafloor devices would not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of seafloor devices during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

Testing Activities

Section 3.0.5.3.3.4 (Seafloor Devices) lists the number and locations where seafloor devices are used. As discussed in Section 3.0.5.3.3.4 (Seafloor Devices), under the No Action Alternative, seafloor devices occur in the Gulf of Mexico, Northeast, and Southeast U.S. Continental Shelf Large Marine Ecosystems, as well as Gulf Stream Open Ocean Area—specifically within the VACAPES and Northeast Range Complexes; Naval Undersea Warfare Center Division, Newport Testing Range; and Naval Surface Warfare Center, Panama City Division Testing Range. A few events could also occur at any of the pierside testing locations. 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. Additionally, sea turtles in coastal habitats can occur near the bottom when foraging or resting. These species are distributed widely in all offshore portions of the Study Area.

Under the No Action Alternative, exposure to seafloor devices used in testing activities may cause short-term disturbance to an individual turtle or, if struck, could lead to injury or death. However, objects falling through the water column will slow as they sink toward the bottom and could be avoided by most sea turtles. Potential impacts of exposure to seafloor devices 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 seafloor devices are not expected to result in population-level impacts. Seafloor devices would not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.3.4.2 Alternative 1

Training Activities

Section 3.0.5.3.3.4 (Seafloor Devices) lists the number and locations where seafloor devices are used. As discussed in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 1, the number of activities using seafloor devices would increase by 44 percent compared to the No Action Alternative. The activities using seafloor devices under Alternative 1 would occur in the same geographic locations as the No Action Alternative. 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. Additionally, sea turtles in coastal habitats can occur near the bottom when foraging or resting. These species are distributed widely in all offshore portions of the Study Area.

Under Alternative 1, exposure to seafloor devices used in training activities may cause short-term disturbance to an individual turtle or, if struck, could lead to injury or death. However, objects falling through the water column will slow as they sink toward the bottom and could be avoided by most sea turtles. Potential impacts of exposure to seafloor devices 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 seafloor devices are not expected to result in population-level impacts. Seafloor devices would not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

Testing Activities

Section 3.0.5.3.3.4 (Seafloor Devices) lists the number and locations where seafloor devices are used. As discussed in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 1, the number of activities using seafloor devices would increase by approximately two times compared to the No Action Alternative. The activities using seafloor devices under Alternative 1 would occur in the same geographic locations as the No Action Alternative. In addition, testing activities that expend seafloor devices would occur in the Navy Cherry Point and JAX Range Complexes as well as throughout the Gulf of Mexico. 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. Additionally, sea turtles in coastal habitats can occur near the bottom when foraging or resting. These species are distributed widely in all offshore portions of the Study Area.

Under Alternative 1, exposure to seafloor devices used in testing activities may cause short-term disturbance to an individual turtle or, if struck, could lead to injury or death. However, objects falling through the water column will slow as they sink toward the bottom and could be avoided by most sea turtles. Potential impacts of exposure to seafloor devices 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 seafloor devices are not expected to result in population-level impacts. Seafloor devices would not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.3.4.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and locations of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be as described in Section 3.5.3.3.4.2 (Alternative 1).

Pursuant to the ESA, the use of seafloor devices during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

Testing Activities

Section 3.0.5.3.3.4 (Seafloor Devices) lists the number and locations where seafloor devices are used. As discussed in Section 3.0.5.3.3.4 (Seafloor Devices), under Alternative 2, the number of activities using seafloor devices is about twice that of the No Action Alternative, but only an increase of 13 percent compared to Alternative 1. The activities using seafloor devices under Alternative 2 would occur in the same geographic locations as the No Action Alternative. In addition, testing activities that expend seafloor devices would also occur in the Navy Cherry Point and JAX Range Complexes as well as throughout the Gulf of Mexico. 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. These species are distributed widely in all offshore portions of the Study Area.

Under Alternative 2, exposure to seafloor devices used in testing activities may cause short-term disturbance to an individual turtle or, if struck, could lead to injury or death. However, objects falling through the water column will slow as they sink toward the bottom and could be avoided by most sea turtles. Potential impacts of exposure to seafloor devices 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 seafloor devices are not expected to result in population-level impacts. Seafloor devices would not overlap with any designated sea turtle critical habitat.

Pursuant to the ESA, the use of seafloor devices during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback turtles; and*
- *will have no effect on sea turtle critical habitat.*

3.5.3.4 Entanglement Stressors

This section analyzes the potential for entanglement of sea turtles with the various types of expended materials used by the Navy during training and testing activities within the Study Area. This section does not analyze impacts on critical habitat because Section 3.5.3.3.3 (Impacts from Military Expended Materials) already analyzed the potential impacts of expended materials on designated critical habitat. This analysis includes the potential impacts from two types of military expended materials: (1) fiber optic cables and guidance wires and (2) parachutes. Aspects of entanglement stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.4 (Conceptual Framework for Assessing Effects from Entanglement). 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 3.0.5.3.4 (Entanglement Stressors).

3.5.3.4.1 Impacts from Fiber Optic Cables and Guidance Wires

Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires) discusses the types of activities that use cables and wires, where they are used, and how many events will occur under each alternative. A sea turtle that becomes entangled in nets, lines, ropes, or other foreign objects underwater may suffer only a temporary hindrance to movement before it frees itself, may suffer minor injuries but recover fully, or it may die as a result of the entanglement.

The likelihood of a sea turtle encountering and becoming entangled in a fiber optic cable or guidance wire depends on several factors. The amount of time that the fiber optic cable or guidance wire is in the same vicinity as a sea turtle can increase the likelihood of it posing an entanglement risk. Since these items 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 sink to the seafloor at a rate of 0.7 ft. (0.2 m) per second; therefore it is most likely that a sea turtle would encounter a guidance wire once it had settled to the seafloor. The length of the cable or wire may influence the ability of a sea turtle to encounter or become entangled in these items. The length of fiber optic cables and guidance wires vary. Fiber optic cables can range in size up to about 900 ft. (300 m). Greater lengths of these items may increase the likelihood that a sea turtle could become entangled. The behavior and feeding strategy of a species can also determine whether they may encounter items on the seafloor, where fiber optic cables and guidance wires will most likely be available. There is potential for those species that feed on the seafloor to encounter these items and potentially become entangled; however, the relatively few fiber optic cables and guidance wires being expended within the Study Area limits the potential for encounters. Lastly, the properties of the items themselves may limit the risk of entanglement. The physical characteristics of guidance wires and fiber optic cables are detailed in Section 3.0.5.3.4 (Entanglement Stressors). This analysis indicates that these items pose a potential, although unlikely, entanglement risk to sea turtles. For instance, the physical characteristics of the fiber optic material render the cable brittle and easily broken when kinked, twisted, or bent sharply (i.e., to a radius greater than 360 degrees). Thus, the fiber optic cable would not loop, greatly reducing or eliminating any potential issues of entanglement with regard to marine life. 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.

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). Except for a chance encounter with the guidance wire at the surface or in the water column while the cable or wire is sinking to the seafloor, a sea turtle would be vulnerable to entanglement only if its diving and feeding patterns place it in direct contact with the bottom. Bottom-feeding sea turtles tend to forage in nearshore areas, and these wires are expended in deeper waters.

Tube-launched, optically tracked, wire-guided (TOW) missiles would expend wires in the nearshore or offshore waters of the Navy Cherry Point Range Complex during training only and are discussed together with torpedo guidance wires because their potential impacts would be similar to those for torpedo guidance wires, which are also expended in the Navy Cherry Point Range Complex.

3.5.3.4.1.1 No Action Alternative

Training Activities

As discussed in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under the No Action Alternative, fiber optic cables would be expended in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as the Gulf Stream and North Atlantic Gyre Open Ocean Areas—specifically within the VACAPES, Navy Cherry Point, and JAX Range Complexes. The area that will have the greatest concentration of expended fiber optic cables or guidance wires is within the VACAPES Range Complex (specifically W-50). The W-50 location includes 123 nm^2 of sea space. Under the No Action Alternative, there would be approximately six fiber optic cables per nm^2 if they were expended evenly throughout the area.

As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under the No Action Alternative, torpedoes expending guidance wire would occur in the Northeast and Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream and North Atlantic Gyre Open Ocean Areas—specifically within the Northeast, VACAPES, Navy Cherry Point, and JAX Range Complexes as well as the Gulf of Mexico. Guidance wires would be concentrated in the Southeast U.S. Continental Shelf Large Marine Ecosystem in the JAX Range Complex. Guidance wires could also be expended outside the range complexes—specifically within the Sinking Exercise Box.

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, Kemp's ridley, and loggerhead 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.

Under the No Action Alternative, 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, cables and wires are generally not expected to cause disturbance to sea turtles because of (1) the relatively low number of cables and wires expended, (2) the physical characteristics of the cables and wires, and (3) 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 fiber optic cables and guidance wires during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

Testing Activities

As discussed in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under the No Action Alternative, activities that expend fiber optic cables would occur in the Northeast and Southeast U.S. Continental Shelf, and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream Open Ocean Area—specifically within the VACAPES Range Complex and Naval Surface Warfare Center Panama City, Division Testing Range. Training events using fiber optic cables would be equally split between these two locations.

As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under the No Action Alternative, torpedoes expending guidance wire would occur in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area—specifically within the Northeast, VACAPES, Navy Cherry Point, and JAX Range Complexes. Fiber optic cables and guidance wires would be expended with greatest concentration in the Gulf of Mexico Large Marine Ecosystem (specifically Naval Surface Warfare Center, Panama City Division Testing Range). Under the No Action Alternative, there would be approximately one fiber optic cable per 17 nm^2 if they were expended evenly throughout the areas. Guidance wire could also be expended outside the range complexes—specifically within the Sinking Exercise Box.

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, Kemp's ridley, and loggerhead 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. Based on the low concentration described above and the likely location of these cables and wires relative to the preferred habitat of the species, the likelihood of an animal encountering one of these items is extremely low.

Under the No Action Alternative, 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 cables and wires 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 relatively low number of cables and wires expended, (2) the physical characteristics of the cables and wires, and (3) 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 fiber optic cables and guidance wires during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

3.5.3.4.1.2 Alternative 1

Training Activities

As discussed in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 1, more than three times as many fiber optic cables and 21 percent more guidance wires, compared to the No Action Alternative, would be expended during training activities. As with the No Action Alternative, they could be expended anywhere within the Study Area but would be expended with greatest concentration in the Northeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area (specifically the VACAPES Range Complex). This would result in a maximum concentration of approximately one fiber optic cable every 16 nm^2 if they were expended evenly throughout the area.

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, Kemp's ridley, and loggerhead 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. Based on the low concentration described above and the likely location of these cables and wires relative to the preferred habitat of the species, the likelihood of an animal encountering one of these items is extremely low.

In comparison to the No Action Alternative, the increase in activities presented in Alternative 1 may increase the risk of sea turtles being exposed to cables and wires. Additionally, the introduction of activities in the GOMEX Range Complex and Other AFTT Areas may expose additional sea turtles that would not have been encountered by activities under the No Action Alternative. However, the differences in species overlap and potential impacts from cables and wires on sea turtles during training activities would not be discernible from those described for training activities in Section 3.5.3.4.1.1 (No Action Alternative). For the reasons stated in Section 3.5.3.4.1.1 (No Action Alternative), the use of cables and wires 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 fiber optic cables and guidance wires during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

Testing Activities

As discussed in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 1, the number of activities that expend fiber optic cables is more than two times that of the No Action

Alternative. The activities using fiber optic cables under Alternative 1 would occur in the same geographic locations as the No Action Alternative, except that activities may occur in the JAX Range Complex and throughout the Gulf of Mexico. This would result in a maximum concentration of approximately one cable per 7 nm^2 if they were expended evenly throughout the area. As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 1, the number of torpedo activities that expend guidance wire is almost six times that of the No Action Alternative. The torpedo activities using guidance wire under Alternative 1 would occur in the same geographic locations as the No Action Alternative, except for introducing guidance wires in the Gulf of Mexico portion of the Study Area and eliminating guidance wire use in the Navy Cherry Point Range Complex.

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, Kemp's ridley, and loggerhead 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.

In comparison to the No Action Alternative, the increase in activities presented in Alternative 1 may increase the risk of sea turtles being exposed to cables and wires. Additionally, the introduction of activities in the Gulf of Mexico portion of the Study Area may expose additional sea turtles that would not have been encountered during activities under the No Action Alternative. However, the differences in species overlap and potential impacts from cables and wires on sea turtles during testing activities would not be discernible from those described for testing activities in Section 3.5.3.4.1.1 (No Action Alternative). For the same reasons stated in Section 3.5.3.4.1.1 (No Action Alternative), the use of cables and wires 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. Potential impacts of exposure to cables and wires are not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

3.5.3.4.1.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and locations of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be as described in Section 3.5.3.4.1.2 (Alternative 1).

Pursuant to the ESA, the use of fiber optic cables and guidance wires during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

Testing Activities

As described in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 2, the number of testing activities that expend fiber optic cables is 2.5 times higher than that of the No Action Alternative but only increases by about 17 percent compared to Alternative 1. The testing activities using fiber optic cables under Alternative 2 would occur in the same geographic locations as the No Action Alternative, except that activities may occur in the JAX Range Complex and throughout the Gulf of Mexico. This would result in a maximum concentration of approximately one cable per 7 nm^2 if they were expended randomly in this area.

As indicated in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires), under Alternative 2, the number of torpedo activities that expend guidance wire is approximately seven times that of the No Action Alternative but only increases by about 13 percent compared to Alternative 1. The torpedo activities using guidance wire under Alternative 2 would occur in the same geographic locations as the No Action Alternative, except for introducing guidance wires in the Gulf of Mexico portion of the Study Area and eliminating guidance wire use in the Navy Cherry Point Range Complex.

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, Kemp's ridley, and loggerhead 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.

In comparison to the No Action Alternative and Alternative 1, the increase in activities presented in Alternative 2 may increase the risk of sea turtles being exposed to cables and wires. Additionally, the introduction of activities in the Gulf of Mexico portion of the Study Area may expose additional sea turtles that would not have been encountered under the No Action Alternative. However, the differences in species overlap and potential impacts from cables and wires on sea turtles during testing activities would not be discernible from those described for testing activities in Section 3.5.3.4.1.1 (No Action Alternative). For the reasons stated in Section 3.5.3.4.1.1 (No Action Alternative), the use of cables and wires 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. Potential impacts of exposure to cables and wires are not expected to result in population-level impacts.

Pursuant to the ESA, the use of fiber optic cables and guidance wires during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

3.5.3.4.2 Impacts from Parachutes

Parachutes of varying sizes are used during training and testing activities. Section 3.0.5.3.4.2 (Parachutes) discusses the types of activities that use parachutes, physical characteristics of these expended materials, where they are used, and how many activities would occur under each alternative.

Because of the physical characteristics of parachutes discussed in Section 3.0.5.3.4.2 (Parachutes), they pose a potential, though unlikely, entanglement risk to sea turtles. The parachute and housing are designed to sink to the seafloor and become flattened after being on the surface for a very short time. Parachutes or lines associated with the parachute may present a potential risk for sea turtles to become entangled, particularly while at the surface. To become entangled, a sea turtle would have to surface to breathe or grab prey from under the parachute, and swim into the parachute or the associated lines, during the brief time before the parachute sinks to the bottom.

While in the water column, a sea turtle is not likely to become entangled because the parachute would have to land directly on the turtle, or the turtle would have to swim into the parachute before it sank. If the parachute and associated lines sink to the seafloor in an area where the bottom is calm, it would remain there undisturbed. In an area with bottom currents or active tidal influence, the parachute may move along the seafloor, away from the location in which it was expended. Over time, it 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. Bottom-feeding sea turtles tend to forage in nearshore areas rather than offshore, where these parachutes are used; therefore, green, hawksbill, Kemp's ridley, and loggerhead sea turtles are not likely to encounter parachutes once they reach the seafloor. The potential for a leatherback sea turtle to encounter an expended parachute while feeding at the surface or in the water column is still extremely low, given the sink rate of the parachute, and is even less probable at the seafloor, given the general behavior of the species to feed near the surface.

3.5.3.4.2.1 No Action Alternative

Training Activities

As discussed in Section 3.0.5.3.4.2 (Parachutes), under the No Action Alternative, activities involving parachute use would occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream and North Atlantic Gyre Open Ocean Areas—specifically within the Northeast, VACAPES, Navy Cherry Point, and JAX Range Complexes, and anywhere in the Gulf of Mexico portion of the Study Area, as well as anywhere in the Study Area, outside the range complexes while vessels are in transit. To estimate a worst-case scenario, calculations were made for the area where parachutes would be expended with the greatest concentration. For training events, the greatest concentration would occur in the Southeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area (specifically, the JAX Range Complex). Under the No Action Alternative, there would be a concentration of approximately one parachute per 2 nm^2 if they were evenly expended throughout the area. Any species of sea turtle that occurs in the Study Area could at some time encounter expended parachutes.

Under the No Action Alternative, exposure to 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 parachute, it could free itself or the entanglement could lead to injury or death. Potential impacts of exposure to a parachute may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, parachutes are generally not expected to cause disturbance to sea turtles because (1) the parachute and housing are designed to sink to the seafloor and become flattened after being on the surface for a very short time 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 parachutes are not expected to result in population-level impacts.

Pursuant to the ESA, the use of parachutes during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

Testing Activities

As discussed in Section 3.0.5.3.4.2 (Parachutes), under the No Action Alternative, testing activities involving parachute use would occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream and North Atlantic Gyre Open Ocean Areas—specifically within the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes and in the Sinking Exercise Box outside the range complexes. To estimate a worst-case scenario, calculations were made for the area where parachutes would be expended with the greatest concentration. For testing events, the greatest concentration would occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem and the Gulf Stream Open Ocean Area (specifically, in the VACAPES Range Complex). Under the No Action Alternative, there would be a concentration of approximately one parachute per 22 nm^2 if the parachutes were expended evenly throughout the area. Any species of sea turtle that occurs in the Study Area could at some point in time encounter expended parachutes.

Under the No Action Alternative, exposure to parachutes 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 parachute, it could free itself or the entanglement could lead to injury or death. Potential impacts of exposure to a parachute may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. However, parachutes are generally not expected to cause disturbance to sea turtles because (1) the parachute and housing are designed to sink to the seafloor and become flattened after being on the surface for a very short time 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 parachutes are not expected to result in population-level impacts.

Pursuant to the ESA, the use of parachutes during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

3.5.3.4.2.2 Alternative 1

Training Activities

As discussed in Section 3.0.5.3.4.2 (Parachutes), under Alternative 1, the number of activities involving the use of parachutes is 5 percent higher than that of the No Action Alternative. In addition to the geographic locations identified in the No Action Alternative, parachutes would also be expended in the Key West and GOMEX Range Complexes. Under Alternative 1, there would be a concentration of approximately one parachute per 2 nm^2 if the parachutes were expended evenly throughout the area. Any species of sea turtle that occurs in the Study Area could at some time encounter expended parachutes.

In comparison to the No Action Alternative, the increase in training activities presented in Alternative 1 may increase the risk of sea turtles being exposed to parachutes. Additionally, the introduction of activities in the Key West and GOMEX Range Complexes may expose additional sea turtles that would not been encountered under the No Action Alternative. However, the differences in species overlap and potential impacts from parachutes on sea turtles during training activities would not be discernible from those described in Section 3.5.3.4.2.1 (No Action Alternative). For the reasons stated in Section 3.5.3.4.2.1 (No Action Alternative), the use of parachutes 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 parachute, it could free itself or the entanglement could lead to injury or death. Potential impacts of exposure to parachutes 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 parachutes are not expected to result in population-level impacts.

Pursuant to the ESA, the use of parachutes during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

Testing Activities

As discussed in Section 3.0.5.3.4.2 (Parachutes), under Alternative 1 the number of activities involving the use of parachutes is four times that of the No Action Alternative. The activities using parachutes under Alternative 1 would occur in the same geographic locations as the No Action Alternative, except for introducing parachutes in the Key West Range Complex; and anywhere in the Gulf of Mexico portion of the Study Area. Some activities could occur throughout the Study Area, including outside the range complexes while vessels are in transit. To estimate a worst-case scenario, calculations were made for the area where parachutes would be expended with the greatest concentration. For testing events, the greatest concentration would occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem and the Gulf Stream Open Ocean Area (specifically, in the VACAPES Range Complex). Under Alternative 1, there would be a concentration of approximately one parachute per 5 nm^2 if the parachutes were expended evenly throughout the area. Any species of sea turtle that occurs in the Study Area could at some point in time encounter expended parachutes.

In comparison to the No Action Alternative, the increase in testing activities presented in Alternative 1 may increase the risk of sea turtles being exposed to parachutes. Additionally, the introduction of activities in the Gulf of Mexico and anywhere in the Study Area, outside the range complexes while vessels are in transit, may expose additional sea turtles that would not have been encountered under the No Action Alternative. However, the differences in species overlap and potential impacts from parachutes on sea turtles during testing activities would not be discernible from those described in Section 3.5.3.4.2.1 (No Action Alternative). For the reasons stated in Section 3.5.3.4.2.1 (No Action Alternative), the use of parachutes 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 parachute, it could free itself or the entanglement could lead to injury or death. Potential impacts of exposure to parachutes 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 parachutes are not expected to result in population-level impacts.

Pursuant to the ESA, the use of parachutes during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

3.5.3.4.2.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and locations of training activities under Alternative 2 are nearly identical to training activities under Alternative 1 (i.e., three additional parachutes). Therefore, impacts and comparisons to the No Action Alternative will also be as described in Section 3.5.3.4.2.2 (Alternative 1).

Pursuant to the ESA, the use of parachutes during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

Testing Activities

As discussed in Section 3.0.5.3.4.2 (Parachutes), under Alternative 2, the number of activities involving the use of parachutes is more than five times that of the No Action Alternative but only increases by about 19 percent compared to Alternative 1. The activities using parachutes would occur in the same geographic locations as the No Action Alternative, except for introducing parachutes in the Key West Range Complex, anywhere in the Gulf of Mexico portion of the Study Area, and anywhere in the Study Area, outside the range complexes while vessels are in transit. Under Alternative 2, there would be a concentration of approximately one parachute per 4 nm^2 if the parachutes were expended evenly throughout the area.

In comparison to the No Action Alternative and Alternative 1, the increase in testing activities presented in Alternative 2 may increase the risk of sea turtles being exposed to parachutes. Additionally, the introduction of activities in the Key West Range Complex, anywhere in the Gulf of Mexico, and anywhere in the Study Area, outside the range complexes while vessels are in transit, may expose additional sea turtles that would not have been encountered under the No Action Alternative. However, the differences in species overlap and potential impacts from parachutes on sea turtles during testing activities would not be discernible from those described in Section 3.5.3.4.2.1 (No Action Alternative). For the reasons stated in Section 3.5.3.4.2.1 (No Action Alternative), the use of parachutes 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 parachute, it could free itself or the entanglement could lead to injury or death. Potential impacts of exposure to parachutes 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 parachutes are not expected to result in population-level impacts.

Pursuant to the ESA, the use of parachutes during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, loggerhead, or leatherback sea turtles.*

3.5.3.5 Ingestion Stressors

This section analyzes the potential ingestion impacts of the various types of expended materials used by the Navy during training and testing activities within the Study Area. Aspects of ingestion stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.5 (Conceptual Framework for Assessing Effects from Ingestion). This analysis includes two categories of military expended materials: (1) munitions (both non-explosive practice munitions and fragments from high-explosive munitions), which are expected to sink to the seafloor, and (2) military expended materials other than munitions (including fragments from targets, chaff, flares, and parachutes), which may remain at the surface or in the water column for some time prior to sinking. This section does not analyze impacts on critical habitat because Section 3.5.3.3.3 (Impacts from Military Expended Materials) already analyzed the potential impacts of expended materials on designated critical habitat.

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. 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. Floating material could be eaten by turtles, such as leatherbacks that feed at or near the water surface, while materials that sink to the seafloor pose a potential risk to bottom-feeding turtles such as hawksbills. Descriptions of feeding behavior by species appear in Sections 3.5.2.4 (Green Sea Turtle [*Chelonia mydas*]) through 3.5.2.10 (American Alligator [*Alligator mississippiensis*]).

Leatherbacks feed primarily on jellyfish throughout the water column and may mistake floating debris for prey. Items found in a sample of leatherbacks who had ingested plastic included plastic bags, fishing line, twine, Mylar balloon fragments, and a plastic spoon (Mrosovsky et al. 2009). Kemp's ridleys, loggerheads, and green turtles in coastal Florida were found to ingest bits of plastic, tar, rubber, and aluminum foil (Bjorndal et al. 1994). Oceanic-stage loggerhead turtles in the North Atlantic were found to ingest "small pieces of hard plastic," corks, and white Styrofoam pieces (Frick et al. 2009). Juvenile loggerheads in the Mediterranean ingested plastic most frequently, followed by tar, Styrofoam, wood, feathers, lines, and net fragments (Tomás et al. 2002). Similar trends in types of items ingested were observed in Kemp's ridley, loggerhead, and green turtles off the Texas coast (Stanley et al. 1988), in loggerheads in the Adriatic Sea (Lazar and Gracan 2011), and in green turtles in the Pacific Ocean (Parker et al. 2011). The variety of items ingested by turtles suggests that feeding is nondiscriminatory and they are prone to ingesting nonprey items. 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 and Bjorndal 1999). Poor nutrient intake can lead to decreased growth rates, depleted energy, reduced reproduction, and decreased survivorship. These long-term sublethal impacts may lead to population-level impacts, but this is difficult to assess because the compromised individuals remain at sea and the trends may only arise after several generations have passed.

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, as depth in areas where munitions are fired ranges from about 20 to 200 m in areas far offshore. While these depths may be within the diving capabilities of most sea turtle species, bottom foraging species (i.e., greens, hawksbills, Kemp's ridleys, and loggerheads) are more likely to forage in the shallower waters. This overlaps with only a small portion of the depth range at which munitions are expended. The consequences of ingestion could range from temporary and inconsequential to long-term physical stress or even death. Aspects of ingestion stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.5 (Conceptual Framework for Assessing Effects from Ingestion).

3.5.3.5.1 Impacts from Munitions or Fragments from High-Explosive Munitions

Many different types of explosive and non-explosive practice munitions are expended at sea during training and testing activities. This section analyzes the potential for sea turtles to ingest non-explosive practice munitions and fragments from high-explosive munitions. This section does not analyze impacts on critical habitat because Section 3.5.3.3.3 (Impacts from Military Expended Materials) already analyzed the potential impacts of munitions on designated critical habitat.

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. A discussion of the types, numbers, and locations of activities using these devices under each alternative is presented in Sections 3.0.5.3.5.1 (Non-Explosive Practice Munitions).

Types of high-explosive munitions that can result in fragments include demolition charges, grenades, projectiles, missiles, and bombs. Fragments would result from fractures in the munitions casing and would vary in size depending on 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. A discussion of the types, numbers, and locations of activities using these devices under each alternative is presented in Section 3.0.5.3.5.2 (Fragments from High-Explosive Munitions).

Because green, loggerhead, Kemp's ridley, and hawksbill 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. 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, Kemp's ridley, and hawksbill turtles and ingestible materials expended nearshore, within range complexes and testing ranges.

3.5.3.5.1.1 No Action Alternative

Training Activities

As discussed in Section 3.0.5.3.5.1 (Non-Explosive Practice Munitions), under the No Action Alternative, the areas with the greatest amount of small- and medium-caliber projectiles would occur in the Northeast and Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream Open Ocean Area—specifically within the VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes. Use of small- and medium-caliber projectiles is concentrated within the VACAPES and JAX Range Complexes. The amount of small- and medium-caliber projectiles that an individual animal would encounter is generally low based on the patchy distribution of both the projectiles and the animal's feeding habitat.

As discussed in Section 3.0.5.3.5.2 (Fragments from High-Explosive Munitions), under the No Action Alternative, the areas with the greatest amount of high-explosive munitions would occur in the Northeast and Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream Open Ocean Area—specifically within the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. In addition, activities would occur outside the range complexes in the Sinking Exercise Box. Use of high-explosive munitions is concentrated within the VACAPES Range Complex. The amount of high-explosive munitions fragments that an individual animal would encounter is generally low based on the patchy distribution of both the munitions and the animal's feeding habitat.

Sublethal impacts due to ingestion of 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 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 projectile 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. However, 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 its digestive tract and expel the item without impacting the individual. Potential impacts of exposure to munitions are not expected to result in population-level impacts.

Pursuant to the ESA, the potential for ingestion of munitions from training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, loggerhead, Kemp's ridley, and hawksbill sea turtles; and*
- *will have no effect on leatherback sea turtles.*

Testing Activities

As indicated in Section 3.0.5.3.5.1 (Non-Explosive Practice Munitions), under the No Action Alternative, the areas with the greatest amount of small- and medium-caliber projectiles would occur in the Northeast and Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream Open Ocean Area—specifically within the VACAPES, JAX, and GOMEX Range Complexes and the Naval Surface Warfare Center, Panama City Division Testing Range. The amount of small- and medium-caliber projectiles that an individual animal would encounter is generally low based on the patchy distribution of both the projectiles and the animal's feeding habits.

As discussed in Section 3.0.5.3.5.2 (Fragments from High-Explosive Munitions), under the No Action Alternative, testing activities involving high-explosive munitions would occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream Open Ocean Area. Testing activities would specifically occur within the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes, the Naval Surface Warfare Center, Panama City Division Testing Range, and in other areas outside the range complexes. The amount of high-explosive munitions fragments that an individual animal would encounter is generally low based on the patchy distribution of both the munitions and the animal's feeding habits.

Sublethal impacts due to ingestion of munitions used in testing 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. However, munitions used in testing 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 its digestive tract and expel the item without impacting the individual. Potential impacts of exposure to munitions are not expected to result in population-level impacts.

Pursuant to the ESA, the potential for ingestion of munitions from testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed green, loggerhead, Kemp's ridley, and hawksbill sea turtles; and*
- *will have no effect on leatherback sea turtles.*

3.5.3.5.1.2 Alternative 1

Training Activities

As discussed in Section 3.0.5.3.5.1 (Non-Explosive Practice Munitions), under Alternative 1, the number of small- and medium-caliber projectiles is more than three times that of the No Action Alternative. The activities using small- and medium-caliber projectiles under Alternative 1 would occur in the same geographic locations as the No Action Alternative, except for introducing small- and medium-caliber projectiles in the Northeast Range Complexes, and less than 10 percent of the total small- and medium-caliber projectiles could be expended anywhere in the Study Area, outside the range complexes while vessels are in transit. Any bottom-feeding sea turtle may occur in these range complexes, although the amount of small- and medium-caliber projectiles that an individual animal would encounter is generally low based on the patchy distribution of both the projectiles and the animal's feeding habits.

As discussed in Section 3.0.5.3.5.2 (Fragments from High-Explosive Munitions), under Alternative 1, the number of events that use high-explosive munitions would increase substantially (more than 13 times) compared to the No Action Alternative. The majority of this increase is due to the inclusion of medium-caliber projectiles that were not analyzed as high-explosive munitions under the No Action Alternative. The activities using high-explosive munitions under Alternative 1 would occur in the same geographic locations as the No Action Alternative, except for introducing high-explosive munitions in the Key West Range Complex and in the Other AFTT Areas while vessels are in transit. Use of high-explosive munitions would be most concentrated in the VACAPES and JAX Range Complexes. Any bottom-feeding sea turtle may occur in these range complexes, although the amount of high-explosive munitions fragments that an individual animal would encounter is generally low based on the patchy distribution of both the munitions and the animal's feeding habits.

In comparison to the No Action Alternative, the increase in training activities presented in Alternative 1 increases the risk of sea turtles being exposed to munitions. Additionally, the introduction of activities in the Key West Range Complexes and in Other AFTT Areas may expose additional sea turtles that would not have been encountered under the No Action Alternative. However, the differences in species overlap and potential impacts from munitions on sea turtles during training activities would not be discernible from those described in Section 3.5.3.5.1.1 (No Action Alternative). For the reasons stated in Section 3.5.3.5.1.1 (No Action Alternative), sublethal impacts due to ingestion of munitions used in training activities may cause short-term or long-term disturbance to an individual turtle. Potential impacts of exposure to munitions are not expected to result in population-level impacts.

Pursuant to the ESA, the potential for ingestion of munitions from training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, loggerhead, Kemp's ridley, and hawksbill turtles; and*
- *will have no effect on leatherback sea turtles.*

Testing Activities

As discussed in Section 3.0.5.3.5.1 (Non-Explosive Practice Munitions), under Alternative 1, the amount of small- and medium-caliber projectiles expended is more than four times that of the No Action Alternative. The activities using small- and medium-caliber projectiles under Alternative 1 would occur in the same geographic locations as the No Action Alternative, except for introducing small- and medium-caliber projectiles in the Key West Range Complex, and testing activities could occur throughout the Study Area. The use of small- and medium-caliber projectiles would be most concentrated in the VACAPES and JAX Range Complexes. Any bottom-feeding sea turtle may occur in these range complexes, although the amount of small- and medium-caliber projectiles that an individual animal would encounter is generally low based on the patchy distribution of both the projectiles and the animal's feeding habitat.

As discussed in Section 3.0.5.3.5.2 (Fragments from High-Explosive Munitions), under Alternative 1, the number of events that use high-explosive munitions would increase substantially compared to the No Action Alternative. The majority of this increase is due to the inclusion of medium-caliber projectiles that were not analyzed as high-explosive munitions under the No Action Alternative. The activities using high-explosive munitions under Alternative 1 would occur in the same geographic locations as the No Action Alternative, except for introducing high-explosive munitions in the Key West Range Complex. The use of small- and medium-caliber projectiles would be most concentrated in the VACAPES and JAX Range Complexes. Any bottom-feeding sea turtle may occur in these range complexes, although the amount of high-explosive munitions fragments that an individual animal would encounter is generally low based on the patchy distribution of both the munitions and the animal's feeding habits.

In comparison to the No Action Alternative, the increase in testing activities presented in Alternative 1 increases the risk of sea turtles being exposed to munitions. Additionally, the introduction of activities in the Key West Range Complex may expose additional sea turtles that would not have been encountered under the No Action Alternative. However, the differences in species overlap and potential impacts from munitions on sea turtles during testing activities would not be discernible from those described in Section 3.5.3.5.1.1 (No Action Alternative). For the reasons stated in Section 3.5.3.5.1.1 (No Action Alternative), sublethal impacts due to ingestion of munitions used in testing activities may cause short-term or long-term disturbance to an individual turtle. Potential impacts of exposure to munitions are not expected to result in population-level impacts.

Pursuant to the ESA, the potential for ingestion of munitions from testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed green, loggerhead, Kemp's ridley, and hawksbill turtles; and*
- *will have no effect on leatherback sea turtles.*

3.5.3.5.1.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and locations of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be as described in Section 3.5.3.5.1.2 (Alternative 1).

Pursuant to the ESA, the potential for ingestion of munitions from training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, loggerhead, Kemp's ridley, and hawksbill turtles; and*
- *will have no effect on leatherback sea turtles.*

Testing Activities

As discussed in Section 3.0.5.3.5.1 (Non-Explosive Practice Munitions), under Alternative 2, the amount of small- and medium-caliber projectiles is more than 4times that expended under the No Action Alternative, but it only increases by about 4 percent compared to Alternative 1. The activities using small- and medium- caliber projectiles under Alternative 2 would occur in the same geographic locations as the No Action Alternative, except for introducing small- and medium-caliber projectiles in the Key West Range Complex and testing activities could occur throughout the Study Area. The use of small-and medium-caliber projectiles would be most concentrated in the VACAPES and JAX Range Complexes. Any bottom-feeding sea turtle may occur in these range complexes.

As discussed in Section 3.0.5.3.5.2 (Fragments from High-Explosive Munitions), under Alternative 2, the number of events that use high-explosive munitions would increase more than 14 times compared to the No Action Alternative but only increases by about 7 percent compared to Alternative 1. The majority of this increase is due to the inclusion of medium-caliber projectiles that were not analyzed as high-explosive munitions under the No Action Alternative. The activities using high-explosive munitions under Alternative 2 would occur in the same geographic locations as the No Action Alternative, except for introducing high-explosive munitions in the Key West Range Complex. The use of small- and medium-caliber projectiles would be most concentrated in the VACAPES and JAX Range Complexes. Any bottom-feeding sea turtle may occur in these range complexes.

The increase in testing activities over the No Action Alternative and the slight increase in activities over Alternative 1 increases the risk of sea turtles being exposed to munitions. However, the differences in species overlap and potential impacts from munitions on sea turtles during testing activities would not be discernible from those described in Section 3.5.3.5.1.1 (No Action Alternative). For the reasons stated in Section 3.5.3.5.1.1 (No Action Alternative), sublethal impacts due to ingestion of munitions used in testing activities may cause short-term or long-term disturbance to an individual turtle. Potential impacts of exposure to munitions are not expected to result in population-level impacts.

Pursuant to the ESA, the potential for ingestion of munitions from testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed green, loggerhead, Kemp's ridley, and hawksbill turtles; and*
- *will have no effect on leatherback sea turtles.*

3.5.3.5.2 Impacts from Military Expended Materials Other Than Munitions

Several different types of materials other than munitions are expended at sea during training and testing activities. 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)
- Parachutes (cloth, nylon, and metal weights)

A discussion of the types, numbers, and locations of activities using these devices under each alternative is presented in Section 3.0.5.3.5.3 (Military Expended Materials Other than Munitions). This section does not analyze impacts on critical habitat because Section 3.5.3.3.3 (Impacts from Military Expended Materials) and Section 3.5.3.4 (Entanglement Stressors) already analyzed the potential impacts of military expended materials other than munitions on designated critical habitat.

Because leatherbacks 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, Kemp's ridley, and loggerhead sea turtles may occur in the open ocean during migrations. Given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, this analysis focuses on leatherback sea turtles and those materials expended in the open ocean.

3.5.3.5.2.1 No Action Alternative

<u>Training Activities</u>

As discussed in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions) under the No Action Alternative, activities involving parachute use would occur in the Northeast and Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream and North Atlantic Gyre Open Ocean Areas—specifically within the Northeast, VACAPES, Navy Cherry Point, and JAX Range Complexes, in the Sinking Exercise Box outside the range complexes, and anywhere in the Gulf of Mexico portion of the Study Area.

Under the No Action Alternative, activities involving target materials use would occur in the Northeast and Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream and North Atlantic Gyre Open Ocean Areas—specifically within the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes.

Under the No Action Alternative, activities involving chaff and flare use would occur in the Northeast and Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream Open Ocean Area—specifically within the VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes.

All sea turtle species could potentially be exposed to parachutes, target materials, chaff, or flares in the areas listed above, but given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, leatherback sea turtles are more likely to be exposed.

Given the low number of parachutes expended in the open ocean and the rapid sink rate of the parachute, the likelihood of a leatherback or other sea turtle species encountering and ingesting a parachute is extremely low. The likelihood of a leatherback encountering and ingesting a flare end cap or target fragment is also very low, as leatherbacks typically forage farther offshore rather than within range complexes such as the Key West Range Complex, and other sea turtle species primarily forage on the bottom in nearshore habitats.

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 3.0.5.3.5.3 (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.

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 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, 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 ingest without harm. In addition, 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
- The ability of sea turtles to reject and not swallow nonfood items incidentally ingested

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 potential for ingestion of military expended materials other than munitions from training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed leatherback, green, hawksbill, Kemp's ridley, or loggerhead turtles.*

Testing Activities

As discussed in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions) under the No Action Alternative, activities involving parachute use would occur in the Northeast and Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream and North Atlantic Gyre Open Ocean Areas—specifically within the Northeast, VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes and in the Sinking Exercise Box outside the range complexes. Parachute use under Alternative 1 would increase by 10 percent compared to the No Action Alternative and would be concentrated primarily in the JAX Range Complex.

Under the No Action Alternative, activities involving target materials use would occur in the Northeast and Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream and North Atlantic Gyre Open Ocean Areas—specifically within the Northeast, VACAPES, JAX, and GOMEX Range Complexes. In addition, activities that expend target materials would occur at Naval Surface Warfare Center, Panama City Division Testing Range and within Other AFTT Areas.

Under the No Action Alternative, activities involving chaff and flare use would occur in the Northeast and Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream Open Ocean Area—specifically within the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes.

All sea turtle species could potentially be exposed to parachutes, target materials, chaff, or flares in the areas listed above, but given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, leatherback sea turtles are more likely to be exposed.

Sublethal impacts due to ingestion of military expended materials other than munitions used in testing 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 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, parachutes, target fragments, chaff, and flare components used in testing 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 are primarily bottom-feeders 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 fibers, if ingested, would occur in very low concentration and are similar to spicules, which sea turtles ingest without harm. In addition, 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
- The ability of sea turtles to reject and not swallow nonfood items incidentally ingested

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 potential for ingestion of military expended materials other than munitions during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect ESA-listed leatherback, green, hawksbill, Kemp's ridley, or loggerhead turtles.*

3.5.3.5.2.2 Alternative 1

Training Activities

As discussed in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions) under Alternative 1, the number of activities involving the use of parachutes is about 5 percent higher than that of the No Action Alternative. In addition to the geographic locations identified in the No Action Alternative, parachutes would also be expended in the Key West Range Complex, as well as anywhere in the Study Area, outside the range complexes while vessels are in transit. Any species of sea turtle that occurs in the Study Area could at some time encounter expended parachutes.

Under Alternative 1, the number of activities that expend target-related materials is about four times that of the No Action Alternative. In addition to the geographic locations identified in the No Action Alternative, target-related materials would also be expended in the Northeast Range Complexes, as well as anywhere in the Study Area, outside the range complexes while vessels are in transit.

Under Alternative 1, the number of activities that expend chaff would decrease by about 30 percent from the No Action Alternative, and flares would increase by about 30 percent. The activities using chaff and flares under Alternative 1 would occur in the same geographic locations as the No Action Alternative, with the exception of expending flares within the Northeast Range Complexes.

All sea turtle species could potentially be exposed to parachutes, target materials, chaff, or flares in the areas listed above, but given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, leatherback sea turtles are more likely to be exposed.

In comparison to the No Action Alternative, the increase in training activities presented in Alternative 1 increases the risk of sea turtles being exposed to parachutes, target materials, and flares. Additionally, the introduction of activities in the Northeast Range Complexes and outside the range complexes may expose additional sea turtles that were not analyzed under the No Action Alternative. However, the differences in species overlap and potential impacts from parachutes, target materials, chaff, and flares on sea turtles during training activities would not be discernible from those described in Section 3.5.3.5.2.1 (No Action Alternative). For the reasons stated in Section 3.5.3.5.2.1 (No Action Alternative), 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. 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. The impacts of ingesting these forms of expended materials on sea turtles would be minor because of the factors given for the No Action Alternative, and are not expected to result in population-level impacts.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed leatherback, green, hawksbill, Kemp's ridley, or loggerhead turtles.*

Testing Activities

As discussed in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions) under Alternative 1, the number of activities involving the use of parachutes is approximately four times that of the No Action Alternative. The activities using parachutes under Alternative 1 would occur in the same geographic locations as the No Action Alternative, except for introducing parachutes in the Key West Range Complex; Naval Surface Warfare Center, Panama City Division Testing Range; and anywhere in the Gulf of Mexico portion of the Study Area. In addition, testing activities could expend parachutes throughout the Study Area. Any species of sea turtle that occurs in the Study Area could at some point in time encounter expended parachutes.

Under Alternative 1, the number of activities that expend target-related materials of ingestible size is approximately two times that of the No Action Alternative. In addition to the geographic locations identified in the No Action Alternative, target-related materials would also be expended in the GOMEX Range Complexes. In addition, testing activities could expend target-related materials throughout the Study Area.

Under Alternative 1, the number of activities that expend chaff and flares would increase four times and three times, respectively, compared to the No Action Alternative. The activities using chaff and flares under Alternative 1 would occur in the same geographic locations as the No Action Alternative.

All sea turtle species could potentially be exposed to parachutes, target materials, chaff, or flares in the areas listed above, but given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, leatherback sea turtles are more likely to be exposed.

In comparison to the No Action Alternative, the increase in testing activities presented in Alternative 1 increases the risk of sea turtles being exposed to parachutes, target materials, chaff, and flares. Additionally, the introduction of activities in the Key West Range Complex and the Gulf of Mexico portion of the Study Area may expose additional sea turtles that would not have been encountered under the No Action Alternative. However, the differences in species overlap and potential impacts from parachutes, target materials, chaff, and flares on sea turtles during testing activities would not be discernible from those described in Section 3.5.3.5.2.1 (No Action Alternative). For the reasons stated in Section 3.5.3.5.2.1 (No Action Alternative), sublethal impacts due to ingestion of military expended materials other than munitions used in testing activities may cause short-term or long-term disturbance to an individual turtle. 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. The impacts of ingesting these forms of expended materials on sea turtles would be minor because of the factors given for the No Action Alternative and are not expected to result in population-level impacts.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect ESA-listed leatherback, green, hawksbill, Kemp's ridley, or loggerhead turtles.*

3.5.3.5.2.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and locations of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be as described in Section 3.5.3.5.2.2 (Alternative 1).

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed leatherback, green, hawksbill, Kemp's ridley, or loggerhead turtles.*

Testing Activities

As discussed in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions) under Alternative 2 the number of activities involving the use of parachutes is more than five- times that of the No Action Alternative but only increases by about 20 percent compared to Alternative 1. The activities using parachutes under Alternative 2 would occur in the same geographic locations as the No Action Alternative, except for introducing parachutes in the Key West Range Complex; Naval Surface Warfare Center, Panama City Division Testing Range; and anywhere in the Gulf of Mexico portion of the Study Area. In addition, testing activities could expend parachutes throughout the Study Area.

Under Alternative 2, the number of activities that expend target-related materials that could be of ingestible size is more than 2.5 times that of the No Action Alternative but only increases by about 10 percent from Alternative 1. In addition to the geographic locations identified in the No Action Alternative, target-related materials would also be expended in the GOMEX Range Complexes. In addition, testing activities could expend target-related materials throughout the Study Area.

Under Alternative 2, the number of activities that expend chaff is nearly four times greater than under the No Action Alternative but would only increase by about 10 percent from Alternative 1. Under Alternative 2, the number of activities that expend flares is nearly three times that of the No Action Alternative but would only increase by about 10 percent from Alternative 1. The activities using chaff and flares under Alternative 2 would occur in the same geographic locations as the No Action Alternative.

All sea turtle species could potentially be exposed to parachutes, target materials, chaff, or flares in the areas listed above, but given the very low probability of nearshore, bottom-feeding species encountering and ingesting materials at the surface, leatherback sea turtles are more likely to be exposed.

Under Alternative 2, the increase in testing activities over the No Action Alternative and the slight increase in activities over Alternative 1 increases the risk of sea turtles being exposed to parachutes, target materials, chaff, and flares. Additionally, the introduction of activities in the Key West Range Complex and the Gulf of Mexico portion of the Study Area may expose additional sea turtles that would not have been encountered under the No Action Alternative. However, the differences in species overlap and potential impacts from parachutes, target materials, chaff, and flares on sea turtles during testing activities would not be discernible from those described in Section 3.5.3.5.2.1 (No Action Alternative). For the reasons stated in Section 3.5.3.5.2.1 (No Action Alternative), sublethal impacts due to ingestion of military expended materials other than munitions used in testing activities may cause short-term or long-term disturbance to an individual turtle. 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. The impacts of ingesting these forms of expended materials on sea turtles would be minor because of the factors given for the No Action Alternativeand are not expected to result in population-level impacts.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect ESA-listed leatherback, green, hawksbill, Kemp's ridley, or loggerhead turtles.*

3.5.3.6 Secondary Stressors

This section analyzes potential impacts on sea turtles exposed to stressors indirectly through impacts on their habitat (i.e., sediments and water quality) and prey availability. The activities that potentially contribute to indirect impacts on habitat do not co-occur with ESA-listed American crocodiles or American alligators, and therefore will not be discussed further. For this analysis, indirect impacts on sea turtles via sediments or water quality (not by trophic transfer, e.g., bioaccumulation) are considered here. 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 to an organism. Bioaccumulation is considered in the *Ecosystem Technical Report for the Atlantic Fleet Training and Testing (AFTT) Draft Environmental Impact Statement* (U.S. Department of the Navy 2012b).

Stressors from Navy training and testing activities could pose indirect impacts on turtles via habitat. These include: (1) explosives, (2) explosive byproducts and unexploded ordnance, (3) metals, and (4) chemicals. Activities associated with these stressors and analyses of their potential impacts are discussed in Section 3.1 (Sediments and Water Quality) and Section 3.3 (Marine Habitats).

3.5.3.6.1 Explosives

In addition to directly impacting sea turtles and sea turtle habitat, underwater explosions could impact other species in the food web, including prey species that sea turtles feed on. The impacts of underwater explosions would differ depending on the type of prey species in the area of the blast.

In addition to physical effects of an underwater blast, prey might have behavioral reactions to underwater sound. For instance, prey species might exhibit a strong startle reaction to detonations that might include swimming to the surface or scattering away from the source (Hazel et al. 2007). This startle and flight response is the most common secondary defense among animals (Mather 2004). The abundance of prey species near the detonation point could be diminished for a short period before being repopulated by animals from adjacent waters. Many sea turtle prey items, such as jellyfish and sponges, have limited mobility and ability to react to pressure waves. Any of these scenarios would be temporary, only occurring during activities involving explosives, and no lasting impact on prey availability or the pelagic food web would be expected. Furthermore, most explosions occur in depths exceeding that which normally support seagrass beds, protecting these habitats.

3.5.3.6.2 Explosion Byproducts and Unexploded Ordnance

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 3.1.3.1.3, Ordnance Failure and Low-Order Detonations). Undetonated explosives associated with ordnance disposal and mine clearance are collected after the activity is complete; therefore, potential impacts are assumed to be inconsequential for these activities, but other activities could leave these items on the seafloor. Sea turtles may be exposed by contact with the explosive, contact with contaminants in the sediment or water, and ingestion of contaminated sediments.

High-order explosions consume most of the explosive material, creating typical combustion products. In the case of Royal Demolition Explosive, 98 percent of the products are common seawater constituents; the remaining products are rapidly diluted below threshold impact level (Section 3.1.3.1.5, Impacts from Explosives and Explosion Byproducts). Explosion byproducts associated with high order detonations present no secondary stressors to sea turtles through sediment or water. However, low order detonations and unexploded ordnance present elevated likelihood of impacts on sea turtles.

Indirect impacts of explosives and unexploded ordnance to sea turtles via sediment is possible in the immediate vicinity of the ordnance. Degradation of explosives proceeds via several pathways discussed in Section 3.1.3.1 (Explosives and Explosion Byproducts). Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen and 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 6 to 12 in. (15 to 30 cm) away from degrading ordnance, concentrations of these compounds were not statistically distinguishable from background beyond 3 to 6 ft. (1 to 2 m) from the degrading ordnance (Section 3.1.3.1, Explosives and Explosion Byproducts). Taken together, it is possible that various life stages of sea turtles could be impacted by the indirect impacts of degrading explosives within a very small radius of the explosive 1 to 6 ft. (0.3 to 2 m).

3.5.3.6.3 Metals

Metals are introduced into seawater and sediments as a result of training and testing activities involving vessel hulks, targets, ordnance, munitions, and other military expended materials (Section 3.1.3.2, Metals). Some metals bioaccumulate, and physiological impacts begin to occur only after several trophic transfers concentrate the toxic metals (Section 3.3, Marine Habitats, and Section 4.0, Cumulative Impacts). Indirect impacts of metals to sea turtles via sediment and water involve concentrations several orders of magnitude lower than concentrations achieved via bioaccumulation. Sea turtles may be exposed by contact with the metal, contact with contaminants in the sediment or water, and ingestion of contaminated sediments. Concentrations of metals in seawater are orders of magnitude lower than concentrations in marine sediments. It is extremely unlikely that sea turtles would be indirectly impacted by toxic metals via water.

3.5.3.6.4 Chemicals

Several Navy training and testing activities introduce potentially harmful chemicals into the marine environment, principally flares and propellants for rockets, missiles, and torpedoes. Polychlorinated biphenyls (PCBs) are discussed in Section 3.1.3.3 (Chemicals Other than Explosives), but there is no additional risk to sea turtles because the Proposed Action does not introduce this chemical into the Study Area, and the use of PCBs has been nearly zero since 1979. Properly functioning flares, missiles, rockets, and torpedoes combust most of their propellants, leaving benign or readily diluted soluble combustion byproducts (e.g., hydrogen cyanide). Operational failures allow propellants and their degradation products to be released into the marine environment. Sea turtles may be exposed by contact with contaminated water or ingestion of contaminated sediments.

Missile and rocket fuel poses no risk of indirect impact on sea turtles via sediment. In contrast, the principal toxic components of torpedo fuel, propylene glycol dinitrate and nitrodiphenylamine, adsorb to sediments, have relatively low toxicity, and are readily degraded by biological processes (Section 3.1.3.3, Chemicals Other than Explosives). It is conceivable that various life stages of sea turtles could be indirectly impacted by propellants via sediment in the immediate vicinity of the object (e.g., within a few inches), but these potential effects would diminish rapidly as the propellant degrades.

3.5.3.6.5 No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative) – Training

Pursuant to the ESA, secondary stressors resulting from training activities as described under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect but are not likely to adversely affect ESA-listed leatherback, green, hawksbill, Kemp's ridley, or loggerhead turtles;*
- *will have no effect on ESA-listed American crocodiles or American alligators; and*
- *will have no effect on critical habitat.*

3.5.3.6.6 No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative) – Testing

Pursuant to the ESA, secondary stressors resulting from testing activities as described under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect but are not likely to adversely affect ESA-listed sea turtles;*
- *will have no effect on ESA-listed American crocodiles or American alligators; and*
- *will have no effect on critical habitat.*

3.5.4 Summary of Impacts on Sea Turtles and Other Marine Reptiles

3.5.4.1 Combined Impacts of All Stressors

As described in Section 3.0.5.5 (Resource-Specific Impacts Analysis for Multiple Stressors), this section evaluates the potential for combined impacts of all stressors from the Proposed Action. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in the analyses of each stressor in the sections above and summarized in Section 3.5.4.2 (Endangered Species Act

Determinations). Combined impacts of all stressors are not an issue for crocodilians since they would potentially only be exposed to a single stressor.

There are generally two ways that a sea turtle could be exposed to multiple stressors. The first would be if the animal were exposed to multiple sources of stress from a single activity (e.g., a mine warfare activity may involve explosives and vessels that could introduce potential acoustic and physical strike stressors). The potential for a combination of these impacts from a single activity would depend on the range of effects of each of the stressors and the response or lack of response to that stressor. Most of the activities as described in the Proposed Action involve multiple stressors; therefore, it is likely that if a sea turtle were within the potential impact range of those activities, it may be impacted by multiple stressors simultaneously. This would be more likely to occur during large-scale exercises or activities that span a period of days or weeks (such as a sinking exercise or composite training unit exercise).

Second, an individual sea turtle could be exposed to a combination of stressors from multiple activities over the course of its life. This is most likely to occur in areas where training and testing activities are more concentrated (e.g., near naval ports, testing ranges, and routine activity locations outlined in Table 3.0-2) and in areas that individual sea turtles frequently visit because they are within the animal's home range, migratory route, breeding area, or foraging area. Except for in the few concentrated areas mentioned above, combinations are unlikely to occur because training and testing activities are generally separated in space and time such that it would be very unlikely that any individual sea turtles would be exposed to stressors from multiple activities. However, animals with a small home range intersecting an area of concentrated Navy activity have elevated exposure risks relative to animals that simply transit the area through a migratory route. The majority of the proposed activities are unit level. 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). Time is a factor with respect to the probability of exposure. Because most Navy stressors persist for a time shorter than or equal to the duration of the activity, the odds of exposure to combined stressors is lower than would be the case for persistent stressors. For example, strike stressors cease with the passage of the object; ingestion stressors cease (mostly) when the object settles to the seafloor. The animal would have to be present during each of the brief windows that the stressors occur. Multiple stressors may also have synergistic effects. For example, sea turtles 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. Sea turtles that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to 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 on sea turtles are difficult to predict.

Although potential impacts on certain sea turtle species from the Proposed Action could include injury or mortality, impacts are not expected to decrease the overall fitness or result in long-term population-level impacts of any given population. In cases where potential impacts rise to the level that warrants mitigation, mitigation measures designed to reduce the potential impacts are discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). The potential impacts anticipated from the Proposed Action are summarized in Section 3.5.4.2 (Endangered Species Act Determinations) with respect to the ESA.

3.5.4.2 Endangered Species Act Determinations

Administration of ESA obligations associated with sea turtles are shared between NMFS and U.S. Fish and Wildlife Service, depending on life stage and specific location of the sea turtle. NMFS has jurisdiction over sea turtles in the marine environment, and U.S. Fish and Wildlife Service has jurisdiction over sea turtles on land. The U.S. Fish and Wildlife Service has jurisdiction over the American crocodile and American alligator. Pursuant to the ESA, the Navy has undertaken Section 7 consultation with NMFS for the proposed and ongoing activities in the AFTT Study Area under Alternative 2 (Preferred Alternative), with regard to sea turtles. Because no activities analyzed in this EIS/OEIS occur on land, consultation with U.S. Fish and Wildlife Service is not required for sea turtles. Pursuant to the ESA, the Navy has undertaken Section 7 consultation with U.S. Fish and Wildlife Service for the proposed and ongoing activities in the AFTT Study Area under Alternative 2 (Preferred Alternative), with regard to impacts on the American crocodile and American alligator. Table 3.5-18 below summarizes the Navy's determination of impacts on federally listed reptiles for the Preferred Alternative.

Table 3.5-18: Summary of Endangered Species Act Determinations for Sea Turtles, the American Crocodile, and the American Alligator for Training and Testing Activities for the Preferred Alternative

Navy Activities and Stressors		Green Turtle	Hawksbill Turtle	Kemp's Ridley Turtle	Loggerhead Turtle	Leatherback Turtle	American Crocodile[1]	American Alligator[1]
Acoustic Stressors								
Sonar and Other Active Acoustic Sources	Training Activities	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	No effect	May affect not likely to adversely affect
	Testing Activities	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	No effect	May affect not likely to adversely affect
Explosives	Training Activities	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	No effect	No effect
	Testing Activities	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	No effect	No effect
Pile Driving	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
	Testing Activities	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Swimmer Defense Airguns	Training Activities	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect

[1] For the American crocodile and American alligator, Endangered Species Act determinations for stressors which did not overlap with species occurrence or critical habitat were considered to be 'no effect'.

Table 3.5-18: Summary of Endangered Species Act Determinations for Sea Turtles, the American Crocodile, and the American Alligator for Training and Testing Activities for the Preferred Alternative (Continued)

Navy Activities and Stressors		Green Turtle	Hawksbill Turtle	Kemp's Ridley Turtle	Loggerhead Turtle	Leatherback Turtle	American Crocodile[1]	American Alligator[1]
Acoustic Stressors (Continued)								
Weapons Firing, Launch, and Impact Noise	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
Vessel and Aircraft Noise	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
Energy Stressors								
Electromagnetic Devices	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
High Energy Lasers	Training Activities	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
	Testing Activities	No effect	No effect	No effect	No effect	No effect	No effect	No effect

[1] For the American crocodile and American alligator, Endangered Species Act determinations for stressors which did not overlap with species occurrence or critical habitat were considered to be 'no effect'.

Table 3.5-18: Summary of Endangered Species Act Determinations for Sea Turtles, the American Crocodile, and the American Alligator for Training and Testing Activities for the Preferred Alternative (Continued)

Navy Activities and Stressors		Green Turtle	Hawksbill Turtle	Kemp's Ridley Turtle	Loggerhead Turtle	Leatherback Turtle	American Crocodile[1]	American Alligator[1]
Physical Disturbance and Strike Stressors								
Vessels	Training Activities	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	No effect	No effect
	Testing Activities	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	May affect likely to adversely affect	No effect	No effect
In-Water Devices	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
Military Expended Materials	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
Seafloor Devices	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
Entanglement Stressors								
Fiber Optic Cables and Guidance Wires	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect

[1] For the American crocodile and American alligator, Endangered Species Act determinations for stressors which did not overlap with species occurrence or critical habitat were considered to be 'no effect'.

Table 3.5-18: Summary of Endangered Species Act Determinations for Sea Turtles, the American Crocodile, and the American Alligator for Training and Testing Activities for the Preferred Alternative (Continued)

Navy Activities and Stressors		Green Turtle	Hawksbill Turtle	Kemp's Ridley Turtle	Loggerhead Turtle	Leatherback Turtle	American Crocodile[1]	American Alligator[1]
Entanglement Stressors (Continued)								
Parachutes	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
Ingestion Stressors								
Munitions	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect	No effect
Military Expended Materials Other than Munitions	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
Secondary Stressors								
Secondary Stressors	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect	No effect

[1] For the American crocodile and American alligator, Endangered Species Act determinations for stressors which did not overlap with species occurrence or critical habitat were considered to be 'no effect'.

Note: The scientific names of the listed species are as follows: green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), loggerhead turtle (*Caretta caretta*), leatherback turtle (*Dermochelys coriacea*), American crocodile (*Crocodylus acutus*), and American alligator (*Alligator mississippiensis*).

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3.6 Birds

BIRDS SYNOPSIS

The Navy considered all potential stressors for birds and analyzed the following:

- Acoustic (sonar and other active acoustic sources; explosives and swimmer defense airguns; pile driving; weapons firing, launch, and impact noise; aircraft and vessel noise)
- Energy (electromagnetic devices, high energy lasers)
- Physical disturbance and strikes (aircraft and aerial targets, vessels and in-water devices, military expended materials)
- Ingestion (military expended materials)
- Secondary (general emissions)

Preferred Alternative

- Acoustic: Pursuant to the Endangered Species Act (ESA), the use of sonar and other active acoustic sources may affect but is not likely to adversely affect ESA-listed roseate terns and will have no effect on ESA-listed piping plover (and its critical habitat), ESA-candidate red knot, or ESA-listed Bermuda petrel. The use of explosives, swimmer defense airguns, aircraft, and vessels may affect but is not likely to adversely affect ESA-listed or ESA-candidate bird species, and will have no effect on piping plover critical habitat. Pile driving may affect but is not likely to adversely affect ESA-listed piping plover and roseate terns, and will have no effect on the ESA-candidate red knot, the ESA-listed Bermuda petrel, or piping plover critical habitat. Weapons firing, launch, and impact noise may affect but is not likely to adversely affect ESA-listed Bermuda petrel or roseate terns, the ESA-candidate red knot, and will have no effect on piping plover (and its critical habitat).
- Energy: Pursuant to the ESA, the use of electromagnetic devices during training and testing activities may affect but is not likely to adversely affect ESA-listed piping plover (and its critical habitat), Bermuda petrel, roseate tern, or ESA-candidate red knot. The use of high energy lasers during training and testing activities will have no effect on ESA-listed piping plover (and its critical habitat), Bermuda petrel, roseate tern, or ESA-candidate red knot.
- Physical Disturbance and Strikes: Pursuant to the ESA, the use of aircraft and aerial targets, vessels and in-water devices, and military expended materials may affect but is not likely to adversely affect ESA-listed piping plover, Bermuda petrel, roseate tern, or ESA-candidate red knot, and will have no effect on piping plover critical habitat.
- Ingestion: Pursuant to the ESA, the potential for ingestion of military expended materials used during training and testing activities may affect but is not likely to adversely affect ESA-listed Bermuda petrel or roseate tern and will have no effect on the ESA-listed piping plover or the ESA-candidate red knot.
- Secondary: Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect ESA-listed or ESA-candidate bird species and will have no effect on critical habitat.
- Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the stressors introduced during training and testing activities would not result in a significant adverse effect on migratory bird populations.

3.6.1 INTRODUCTION

This section analyzes potential impacts on birds found in the Study Area. This section introduces the Endangered Species Act (ESA)-listed species, the major taxonomic groups of birds that occur in the Study Area, species protected under the Migratory Bird Treaty Act, and United States (U.S.) Fish and Wildlife Service Birds of Conservation Concern. Section 3.6.2 (Affected Environment) provides detailed information on the baseline affected environment. Complete analysis and summary of potential impacts of the Proposed Action on birds are found in Sections 3.6.3 (Environmental Consequences) and 3.6.4 (Summary of Potential Impacts on Birds), respectively.

3.6.1.1 Endangered Species Act Species

Three bird species that occur in the Study Area are listed as endangered or threatened under the ESA, and one species is a candidate for ESA listing (U.S. Fish and Wildlife Service 2010b). One ESA species, the piping plover, has critical habitat that is described in greater detail in Section 3.6.2.6.1 (Status and Management). The ESA status, presence, and nesting occurrence of ESA-listed birds in the Study Area are listed in Table 3.6-1. These species are discussed further in Section 3.6.2 (Affected Environment).

3.6.1.2 Major Bird Groups

There are 10 major taxonomic groups of birds represented in the Study Area (Table 3.6-2). Birds may be found in the air, at the water's surface, or in the water column of the Study Area. The vertical distribution descriptions provided in Table 3.6-2 provide a representative description of the taxonomic group; however, due to variations in species behavior, these descriptions may not apply to all species within each group. Distribution in the water column is indicative of a species known to dive under the surface of the water (for example, during foraging). More detailed species descriptions, including diving behavior, are provided in Sections 3.6.2.9 (Geese, Swans, Dabbling, and Diving Ducks [Order Anseriformes]) through 3.6.2.18 (Neotropical Migrant Songbirds, Thrushes, Allies, Cuckoos, Swifts, and Owls [Orders Passeriformes, Cuculiformes, and Apodiformes]).

All 10 major taxonomic groups of birds in the Study Area occur in open ocean areas (Labrador Current, North Atlantic Gyre, Gulf Stream) or coastal waters of large marine ecosystems (West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea), as shown in Table 3.6-2. Refer to Figure 3.0-1 for a map of open ocean areas and large marine ecosystems in the Study Area.

3.6.1.3 Migratory Bird Treaty Act Species

A variety of bird species would be encountered in the Study Area including those listed under the Migratory Bird Treaty Act (U.S. Fish and Wildlife Service 2010c). The Migratory Bird Treaty Act established federal responsibilities for protecting nearly all migratory species of birds, eggs, and nests. Bird migration is defined as the periodic seasonal movement of birds from one geographic region to another, typically coinciding with available food supplies or breeding seasons. Of the 1,007 species protected under the Migratory Bird Treaty Act, 184 occur in the Study Area. These species are not analyzed individually, but rather are grouped by taxonomic or behavioral similarities based on the stressor being analyzed. Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 Code of Federal of Regulations [C.F.R.] Part 21), the U.S. Fish and Wildlife Service promulgated a rule that permits the incidental take of migratory birds during Department of Defense (DoD) military readiness activities necessary for national defense (Section 3.0.1, Regulatory Framework). Conclusions of potential impacts on species protected under the Migratory Bird Treaty Act are presented in Section 3.6.4 (Summary of Potential Impacts on Birds).

Table 3.6-1: Endangered Species Act Status and Presence of Endangered Species Act–Listed and Candidate Bird Species in the Study Area

Species Name and Regulatory Status			Presence in the Study Area[1]		
Common Name	**Scientific Name**	**Endangered Species Act Status**	**Open Ocean Area**	**Large Marine Ecosystem**	**Bays, Estuaries, and Rivers**
Bermuda Petrel	*Pterodroma cahow*	Endangered	North Atlantic Gyre (nesting), Gulf Stream	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf	None
Roseate Tern	*Sterna dougallii*	Endangered Threatened[2]	North Atlantic Gyre, Gulf Stream	Scotian Shelf (nesting), Northeast U.S. Continental Shelf (nesting), Southeast U.S. Continental Shelf, Gulf of Mexico (nesting), Caribbean Sea (nesting)	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Cape Fear River (Wilmington, NC); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX)
Piping Plover	*Charadrius melodus*	Threatened	None	Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Cape Fear River (Wilmington, NC); St. Mary's River Inlet (St. Mary's, GA); St. Johns River and Fort George River Inlets (Jacksonville, FL); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX)
Red Knot	*Calidris canutus rufa*	Candidate	North Atlantic Gyre, Gulf Stream	Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea	Sandy Hook Bay (Earle, NJ); Lower Chesapeake Bay (Hampton Roads, VA); Beaufort Inlet Channel (Morehead City, NC); Cape Fear River (Wilmington, NC); St. Andrew Bay (Panama City, FL); Sabine Lake (Beaumont, TX); Corpus Christi Bay (Corpus Christi, TX)

Source: (U.S. Fish and Wildlife Service 2010b), for ESA Status.

Note: The abbreviations in the table are defined as follows—DE: Delaware; FL: Florida; GA: Georgia; NC: North Carolina; NJ: New Jersey; TX: Texas; U.S.: United States; VA: Virginia.

[1] Presence in the Study Area indicates open ocean areas (North Atlantic Gyre, Gulf Stream, and Labrador Current) and coastal waters of large marine ecosystems (West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea) in which the species are found. Open ocean areas and coastal waters where breeding occurs are indicated as (nesting).

[2] The roseate tern is listed as endangered under the ESA along the Atlantic coast south to North Carolina, Canada (Newfoundland, Nova Scotia, Quebec), and Bermuda. It is listed as threatened under the ESA in the Western Hemisphere and adjacent oceans, including Florida, Puerto Rico, and the Virgin Islands.

Table 3.6-2: Major Groups of Birds in the Study Area

Major Bird Groups		Vertical Distribution in the Study Area		
Common Name (Taxonomic Group)	**Description**	**Open Ocean Areas**	**Large Marine Ecosystem**	**Bays, Estuaries, and Rivers**
Geese, Swans, Dabbling and Diving Ducks (Order Anseriformes)	Diverse group of geese, swans, and ducks that inhabit shallow waters, coastal areas, and deeper waters. Feed at the surface by dabbling or by diving in deeper water. Often occur in large flocks.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Loons (Order Gaviiformes)	Superficially duck-like, fish-eating birds that capture prey by diving and underwater pursuit.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Grebes (Order Podicipediformes)	Small diving birds, superficially duck-like. May occur in small groups.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Albatrosses, fulmars, Petrels, Shearwaters, and Storm-Petrels (Order Procellariiformes)	Group of largely pelagic seabirds. Fly nearly continuously when at sea. Soar low over the water surface to find prey. Some species dive below the surface.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Tropicbirds, Boobies, Gannets, Pelicans, Cormorants, and Frigatebirds (Order Pelecaniformes)	Diverse group of large, fish-eating seabirds with four toes joined by webbing. Often occur in large flocks near high concentrations of bait fish.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Herons, Egrets, Ibis, Spoonbill (Order Ciconiiformes)	Small- to medium-sized wading birds with dagger-like, down-curved, or spoon-shaped bills used to capture prey in water or mud.	None	Airborne, surface	Airborne, surface
Flamingos (Order Phoenicopteriformes)	Large, wading birds with unique angled bill to filter invertebrates from water or mud.	None	Airborne, surface	Airborne, surface
Osprey, Bald Eagles, Peregrine Falcons (Orders Accipitriformes, and Falconiformes)	Large raptors that inhabit habitats with open water, including coastal areas. Feed on fish, waterfowl, or other mammals. Migrate and forage over open water.	None	Airborne, surface	Airborne, surface
Shorebirds, Phalaropes, Gulls, Noddies, Terns, Skimmer, Skuas, Jaegers, and Alcids (Order Charadriiformes)	Diverse group of small- to medium-sized shorebirds, seabirds, and allies inhabiting coastal, nearshore, and open-ocean waters.	Airborne, surface, water column	Airborne, surface, water column	Airborne, surface, water column
Neotropical Migrant Songbirds, Warblers, Thrushes, and Allies (Orders Passeriformes Cuculiformes, Strigiformes, and Apodiformes)	Largest and most diverse group of birds in North America, primarily occur in coastal, and inland areas, but often occur in large numbers over the open ocean (particularly over the Gulf of Mexico) during annual spring and fall migration periods.	Airborne	Airborne	Airborne

Sources: American Ornithologists' Union (1998), Sibley (2007), and Onley and Scofield (2007), for major bird taxonomic groups.

3.6.1.4 United States Fish and Wildlife Service Birds of Conservation Concern

Birds of Conservation Concern are species, subspecies, and populations of migratory and nonmigratory birds that the U.S. Fish and Wildlife Service determined to be the highest priority for conservation actions (U.S. Fish and Wildlife Service 2008). The purpose of the Birds of Conservation Concern list is to prevent or remove the need for additional ESA bird listings by implementing proactive management and conservation actions needed to conserve these species. Of the 184 species that occur within the Study Area, 54 are considered Birds of Conservation Concern (Table 3.6-3). These species are not analyzed individually, but rather are grouped by taxonomic or behavioral similarities based on the stressor being analyzed.

Table 3.6-3: Birds of Conservation Concern that Occur within the Study Area

Family/Subfamily	Common Name	Scientific Name
Order Gaviiformes		
Family Gaviidae		
	Common loon	*Gavia immer*
Order Podicipediformes		
Family Podicipedidae		
	Horned grebe	*Podiceps auritus*
	Pied billed grebe	*Podilymbus podiceps*
Order Procellariiformes		
Family Procellariidae		
	Audubon's shearwater	*Puffinus lherminieri*
	Black-capped petrel	*Pterodroma hasitata*
	Greater shearwater	*Puffinus gravis*
Family Hydrobatidae		
	Band-rumped storm petrel	*Oceanodroma castro*
Order Pelecaniformes		
Family Sulidae		
	Brown booby	*Sula leucogaster*
Family Phalacrocoracidae		
	Great cormorant	*Phalacrocorax carbo*
Family Frigatidae		
	Magnificent frigatebird	*Fregata magnificens*
Order Ciconiiformes		
Family Threskiornithidae		
	Roseate spoonbill	*Platalea ajaja*
Family Ardeidae		
	Reddish egret	*Egretta rufescens*
	Snowy egret	*Egretta thula*
Order Falconiformes		
Family Falconidae		
	Peregrine falcon	*Falco peregrinus*

Table 3.6-3: Birds of Conservation Concern that Occur within the Study Area (Continued)

Family/Subfamily	Common Name	Scientific Name
Order Accipitriformes		
Family Accipitridae		
Subfamily Accipitrinae	Bald eagle	*Haliaeetus leucocephalus*
	Swallow-tailed kite	*Elanoides forficatus*
Order Charadriiformes		
Family Charadriidae		
Subfamily Charadriinae	Snowy plover	*Charadrius alexandrinus*
	Wilson's plover	*Charadrius wilsonia*
Family Haematopodidae		
	American oystercatcher	*Haematopus palliatus*
Family Scolopacidae		
	Bar-tailed godwit	*Limosa lapponica*
	Dunlin	*Calidris alpina*
	Hudsonian godwit	*Limosa haemastica*
	Lesser yellowlegs	*Tringa flavipes*
	Marbled godwit	*Limosa fedoa*
	Purple sandpiper	*Calidris maritima*
	Red knot	*Calidris canutus*
	Semipalmated sandpiper	*Calidris pusilla*
	Short-billed dowitcher	*Limnodromus griseus*
	Solitary sandpiper	*Tringa solitaria*
	Whimbrel	*Numenius phaeopus*
Family Laridae		
	Arctic tern	*Sterna paradisaea*
	Black skimmer	*Rynchops niger*
	Gull-billed tern	*Gelochelidon nilotica*
	Least tern	*Sternula antillarum*
	Sandwich tern	*Thalasseus sandvicensis*
Order Passeriformes		
Family Tyrannidae		
	Olive-sided flycatcher	*Contopus cooperi*
Family Turdidae		
	Bicknell's thrush	*Catharus bicknelli*
	Wood thrush	*Hylocichla mustelina*
Family Parulidae		
	Bay-breasted warbler	*Dendroica castanea*
	Blue-winged warbler	*Vermivora pinus*
	Canada warbler	*Wilsonia canadensis*
	Cerulean warbler	*Dendroica cerulea*
	Golden-winged warbler	*Vermivora chrysoptera*
	Kentucky warbler	*Oporornis formosus*
	Prairie warbler	*Dendroica discolor*
	Prothonotary warbler	*Protonotaria citrea*

Table 3.6-3: Birds of Conservation Concern that Occur within the Study Area (Continued)

Family/Subfamily	Common Name	Scientific Name
	Swainson's warbler	*Limnothlypis swainsonii*
	Worm-eating warbler	*Helmitheros vermivorum*
Family Cardinalidae		
	Dickcissel	*Spiza americana*
	Painted bunting	*Passerina ciris*
Order Cuculiformes		
Family Cuculidae		
	Mangrove cuckoo	*Coccyzus minor*
	Yellow-billed cuckoo	*Coccyzus americanus*
Order Strigiformes		
Family Strigiformes		
	Short-eared owl	*Asio flammeus*
Order Apodiformes		
Family Apodidae		
	Black swift	*Cypseloides niger*

3.6.2 AFFECTED ENVIRONMENT

At least 184 bird species occur regularly within the Study Area year-round, seasonally, or during the migration seasons. A combination of short-distance migrants, long-distance migrants, and year-round resident bird species occur within the Study Area and range in size from large pelagic seabirds to small songbirds. Birds are distributed throughout the seven large marine ecosystems and three open ocean areas in coastal, nearshore, and open-ocean habitats of the Study Area. Typical bird behavior to be encountered within the Study Area would include breeding, foraging, roosting, and migration.

The Study Area includes portions of three major migration routes: the Atlantic Flyway, the Atlantic Ocean Flyway, and the Mississippi Flyway that overlap all of the large marine ecosystems detailed in Section 3.0.3.1 (Biogeographic Classifications). Many migratory birds fly close to the coastline of the Atlantic Flyway, although large numbers of birds, such as seaducks, shorebirds, and songbirds, follow the Atlantic Ocean Flyway further offshore (throughout this section, offshore refers to areas beyond the immediate nearshore coastal areas both within and outside of the continental shelf). Many neotropical migrants fly across the Gulf of Mexico at the southern end of the Mississippi Flyway (U.S. Geological Survey 2006).

Birds forage in a variety of habitats such as coastal wetlands, estuaries, kelp beds, lagoons, and in the intertidal zone, as well as nearshore (immediately adjacent to the coastline) in shallower waters, and on the open ocean where they catch prey near or at the ocean surface. When and where birds occur is highly dependent on environmental factors and life stage and varies with prey location and time of year. Due to the uneven distribution of prey within the marine environment, some seabirds must fly long distances to obtain food. Other species like neotropical migrants must fly across open water twice a year to reach their wintering or breeding grounds in the search for food (U.S. Geological Survey 2006).

Bird watching is a very common socioeconomic activity and certain groups have been instrumental in ensuring this pastime continues. Accordingly, Important Bird Areas that protect important breeding, roosting, and foraging habitat and concentrations of birds, including some threatened and endangered species under the ESA, have been designated by the National Audubon Society (a nongovernmental organization). These Important Bird Areas are not protected by federal mandate but occur throughout the Study Area in coastal areas, on off-shore islands, and in some off-shore waters (National Audubon Society 2011). For example, some off-shore areas that support seabird concentrations include the Outer Continental Shelf Important Bird Area, which is within the U.S. Department of the Navy (Navy) Cherry Point Range Complex, and the Stellwagen Bank Important Bird Area, which is within the Boston Operating Area (OPAREA).

Sections 3.6.2.5 (Bermuda Petrel [*Pterodroma cahow*]) through 3.6.2.8 (Red Knot [*Calidris canutus rufa*]) describe ESA-listed species and -candidate species, and Sections 3.6.2.9 (Geese, Swans, Dabbling and Diving Ducks [Order Anseriformes]) through 3.6.2.18 (Neotropical Migrant Songbirds, Thrushes, Allies, Cuckoos, Swifts, and Owls [Orders Passeriformes, Cuculiformes, and Apodiformes]) describe species groups that occur in the Study Area. The emphasis on species-specific information is placed on the ESA-protected species because any threats or potential impacts on those species are subject to consultation with regulatory agencies. Consultation could also occur under the Bald and Golden Eagle Protection Act or the Migratory Bird Treaty Act. Additional information on the biology, life history, and conservation of bird species, including species-specific descriptions, is available from the websites of these sources:

- U.S. Fish and Wildlife Service Endangered Species Program
- Birdlife International
- International Union for Conservation of Nature and Natural Resources Red List of Threatened Species
- National Audubon Society

3.6.2.1 Group Size

A variety of group sizes and diversity may be encountered throughout the Study Area, ranging from solitary migration of an individual bird to large concentrations of mixed-species flocks. Depending on season, location, and time of day, the number of birds observed (group size) will vary and will likely fluctuate from year to year. During spring and fall periods, diurnal and nocturnal migrants would likely occur in large groups as they migrate over open water (Elphick 2007). Avian radar studies at sea show nocturnal migrants as well as seabirds moving across open oceans in large numbers (Desholm et al. 2006; Gauthreaux and Belser 2003). During the winter months, large groups of ducks (rafts) could be encountered. During the nesting and breeding season, pelagic seabirds could be encountered in large groups following the currents and upwellings in pursuit of prey (Sibley 2007). In the nearshore environments, terns, gulls, shorebirds, and plovers may occur in large groups while in their breeding and feeding areas.

Within the Study Area, species diversity of foraging seabirds is higher in the Caribbean Sea and lowest in the northern portion of the Study Area (Karpouzi et al. 2007). Though the northern temperate regions have low species diversity, seabird densities and the amount of prey consumed are greater, due to overall higher productivity of northern waters (Karpouzi et al. 2007). Species particularly abundant in the northwest Atlantic include breeding auks in west Greenland, breeding Leach's storm-petrels (*Oceanodroma leucorhoa*) and northern gannets (*Morus bassanus*) in Newfoundland, and nonbreeding shearwaters and sea ducks (Barrett et al. 2006). Most seabirds forage in offshore waters over the continental shelves of North America (Karpouzi et al. 2007).

Many species forage in large groups on shoaling fish or on concentrations of molluscs attached to the seafloor. Water temperatures, currents, upwellings, wind direction, and ocean floor topography can all influence when, where, and how many seabirds forage (Elphick 2007; Fauchald et al. 2002; Spear and Ainley 1997).

3.6.2.2 Diving

Most of the seabird species found in the Study Area will dive, skim, or grasp prey at the water's surface or within the upper portion (1 to 2 meters [m] or 3 to 6 feet [ft.]) of the water column (Cook et al. 2011; Jiménez et al. 2012; Sibley 2007). Very few seabirds are deep divers, but one exception is the horned grebe, which can dive down to 500 ft. (151 m) (Ehrlich et al. 1988). Some of these species are aerial plunge divers in which they dive from above and make generally shallow dives into the water column after prey (e.g., terns, gannets). Others are considered surface divers where they plunge directly from the surface underwater after prey (e.g., puffins, loons). However, most diving species tend to catch the majority of their prey near the surface of the water column (Cook et al. 2011). More specific diving information in regard to species and taxonomic groups is provided in Sections 3.6.2.5 (Bermuda Petrel [*Pterodroma cahow*]) through 3.6.2.18 (Neotropical Migrant Songbirds, Thrushes, Allies, Cuckoos, Swifts, and Owls [Orders Passeriformes, Cuculiformes, and Apodiformes]).

3.6.2.3 Bird Hearing

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

There is little published literature on the hearing abilities of birds under water, and the manner in which birds may use sound under water is unclear (Dooling and Therrien 2012). In fact, there are no measurements of the underwater hearing ability of any diving birds (Therrien et al. 2011). Diving birds may not hear as well under water, compared to other (non-avian) terrestrial species, based on adaptations to protect their ears from pressure changes (Dooling and Therrien 2012). There are some studies of bird behavior underwater when exposed to sounds, from which some hearing abilities of birds underwater could be inferred. Common murres (*Uria aalge*) were deterred from gillnets by acoustic transmitters emitting 1.5 kHz pings at 120 decibels (dB) referenced (re) to 1 micro-pascal (μPa); however, there was no significant reduction in rhinoceros auklet (*Cerorhinca monocerata*) bycatch in the same nets (Melvin et al. 1999). In another study, firing of guns over water deterred African penguins (*Spheniscus demersus*) from an area, but playback of Orca (*Orcinus orca*) vocalizations did not (Cooper 1982).

3.6.2.4 General Threats

Threats to bird populations in the Study Area include human-caused stressors and natural-caused stressors. Specific Navy stressors that may impact birds are analyzed in more detail in Section 3.6.3 (Environmental Consequences).

In addition to the Navy stressors, human-caused threats include habitat loss and degradation due to development, lack of prey due to overfishing, death from entanglement in commercial fishing gear, light pollution at sea, and ingestion of plastic litter due to pollution (North American Bird Conservation Initiative 2009; Onley and Scofield 2007; Waugh et al. 2012; Weimerskirch 2004). Beach-nesting birds are vulnerable to disturbance from people, pets, and off road vehicles that may inadvertently destroy or disturb nests (North American Bird Conservation Initiative 2009). The introduction of feral species (primarily cats and rats, occasionally pigs and cattle) and plants may destroy nesting colonies. Seabirds are especially vulnerable to feral species on islands where nests and populations have been devastated through predation or habitat destruction (Clavero et al. 2009; North American Bird Conservation Initiative 2009).

Lighting on boats and on offshore oil and gas platforms have also contributed to bird fatalities in open-ocean environments when birds are attracted to these lights, usually in inclement weather conditions (Merkel and Johansen 2011). Recent studies have looked at different lighting systems and how they may impact migrating songbirds (Poot et al. 2008). Oil spills pose a risk to seabirds and shorebirds through direct contamination and destruction of nesting, roosting, and foraging habitats (U.S. Environmental Protection Agency 1999). Natural causes of seabird and shorebird population declines include disease, storms, and harmful algal blooms, although human activities are also associated with harmful algal blooms (Jessup et al. 2009; North American Bird Conservation Initiative 2009, 2010; Onley and Scofield 2007). In addition, seabird distribution, abundance, breeding, and other behaviors are influenced by cyclical environmental events such as El Niño Southern Oscillation (Congdon et al. 2007).

An estimated 39 percent of seabirds that depend on ocean habitats are declining (North American Bird Conservation Initiative 2009). In the long term, global climate change could be the greatest threat to seabirds (North American Bird Conservation Initiative 2010). Climate change impacts include changes in air and sea temperatures, precipitation, the frequency and intensity of storms, and sea level. These changes could impact overall marine productivity, which could in turn have an impact on the food resources, distribution, and reproductive success of seabirds (Aebischer et al. 1990; Congdon et al. 2007; Davoren et al. 2012). Open-ocean species, such as petrels and tropicbirds, are vulnerable to climate change due to their low reproductive rates, their use of islands for nesting, and their reliance on a highly variable marine system (North American Bird Conservation Initiative 2010). Coastal birds are vulnerable to climate change due to rising sea levels, which are expected to impact foraging and nesting habitat quality and quantity by flooding or fragmenting habitats such as barrier islands, beaches, and mudflats (North American Bird Conservation Initiative 2010).

From April to September, 2010, the BP *Deepwater Horizon* off-shore oil platform spilled an estimated 200 million gallons (gal.) (757 million liters [L]) of oil into the Gulf of Mexico (Cornell Lab of Ornithology 2010; U.S. Department of the Interior 2010b). Effects on birds include direct impacts from physical contact, ingestion, inhalation, and absorption of oil; and indirect impacts of oil on long-term reproductive success, and habitat destruction (Mearns et al. 2011; U.S. Department of the Interior 2010b). When oil comes in contact with feathers, their buoyancy and insulating properties are lost, impacting a bird's ability to fly, dive, or float on the water which results in the risk of drowning or freezing to death (Montevecchi et al. 2012). Birds may ingest oil while preening (grooming), which can result in immediate or delayed death due to organ damage. Also, eggs may be damaged when oiled adults sit on nests. Approximately 1.8 million gal. (681 million L) of oil dispersants were used during the *Deepwater Horizon* spill. Dispersants break up large surface oil slicks into small balls that gather and sink deeper in the water column, where they are generally unavailable to foraging birds. The impacts of dispersants on birds are mostly unknown, although dispersant chemicals are less toxic than crude oil (Cornell Lab of Ornithology 2010).

The U.S. gulf coast supports important habitat essential for breeding, wintering, and migratory birds, particularly beach-nesting birds (U.S. Department of the Interior 2010a). The U.S. Fish and Wildlife Service has been monitoring the oil spill's impacts on birds through response and reporting activities (U.S. Department of the Interior 2010d, 2011). Wildlife rescue and collection reports include totals for live and dead birds with visible oiling, no visible oiling, and unknown oiling status. The most current available bird impact report dated 12 May 2011 identified 7,258 birds, covering 132 species, as recovered or rescued; 17 of these species are included in Table 3.6-3. Species with the highest number of impacts were laughing gulls (*Larus atricilla*) (2,981 total impacted birds; 2,719 dead birds), brown pelicans (*Pelecanus occidentalis*) (826 total impacted birds; 546 dead), northern gannets (*Morus bassanus*) (475 total impacted birds; 354 dead), and royal terns (*Sterna maxima*) (289 total impacted birds; 239 dead)(U.S. Department of the Interior 2011).

These numbers represent only a portion of the total birds impacted by the spill (U.S. Department of the Interior 2010e). ESA-listed birds within the Study Area that may be impacted by the oil spill are the roseate terns (*Sterna dougallii*) and piping plovers (*Charadrius melodus*) (U.S. Department of the Interior 2010c). In the 3 November 2010 bird impact report, the U.S. Fish and Wildlife Service reported 110 least terns (*Sternula antillarum*) (98 dead) recovered or rescued (U.S. Department of the Interior 2010e). The areas with the highest concentration of impacted birds (live and dead oiled birds) include coastal and off-shore Louisiana, Mississippi, Alabama, and the Florida panhandle (National Oceanic and Atmospheric Administration 2010). Additional bird impact observation areas include the west coast of Florida, Florida Keys, Texas, and off-shore waters in the vicinity of the oil platform (National Oceanic and Atmospheric Administration 2010). The discussion above represents general threats to birds. Additional threats to individual species within the Study Area are described below in the accounts of those species.

3.6.2.5 Bermuda Petrel (*Pterodroma cahow*)

3.6.2.5.1 Status and Management

The U.S. Fish and Wildlife Service listed the Bermuda petrel as endangered under the ESA in the year 1970. There is no designated critical habitat for this seabird species. This extremely rare seabird nests only on Bermuda in the Atlantic Ocean (White 2004). The Bermuda petrel was thought to be extinct for about three decades until its existence was confirmed in the mid-1900s. In the year 1951, 18 pairs of the Bermuda petrel (commonly referred to as "cahow") were rediscovered breeding on a group of four rocky islets in Castle Harbor, Bermuda. An intensive recovery and management program followed, which included removing predators, such as rats (Murphy and Mowbray 1951), and adapting nest burrow entrances with baffles and artificial burrows to prevent nest site competition with the white-tailed tropicbird (*Phaethon lepturus*) (BirdLife International 2010a; Murphy and Mowbray 1951). Efforts to establish a new breeding colony in the higher areas of Nonsuch Island Nature Reserve have been slow but promising (BirdLife International 2010a; Dobson and Madeiros 2009). There were approximately 250 individuals with 71 breeding pairs in the year 2005 and 96 breeding pairs recorded in the year 2009 (Dobson and Madeiros 2009).

3.6.2.5.2 Habitat and Geographic Range

The petrel is a pelagic species and spends most of its life at sea, except during the breeding season from January to June where it comes ashore to breed. Breeding occurs outside the Study Area, exclusively in Bermuda on four small islets off Nonsuch Island in the North Atlantic Gyre (National Audubon Society 2005). Available islet nesting habitat is limited to 2.4 acres (ac.) (0.97 hectares [ha]), which is occupied by a varying number of breeding pairs each year (BirdLife International 2008). During the breeding season, the Bermuda petrel arrives and leaves the island only at night to avoid predation (Wurster and

Wingate 1968). During the breeding season, the Bermuda petrel nests in colonies, but is otherwise solitary (Onley and Scofield 2007). Due to its solitary behavior they are unlikely to approach ships (Enticott and Tipling 1997; Onley and Scofield 2007). More specific nest density or colony size information was not found.

Open Ocean Areas. In the nonbreeding season (June–December) (Brooke 2004), the species migrates from the breeding grounds in Bermuda to foraging routes over much of the Atlantic Ocean, including waters of the North Atlantic Gyre and the Gulf Stream (includes off-shelf portions of the Virginia Capes [VACAPES] and Navy Cherry Point Range Complexes) (Lee and Mackin 2008; National Audubon Society 2005; Onley and Scofield 2007). However, dispersal and at-sea distribution are generally poorly known (Brooke 2004; Onley and Scofield 2007). One additional migration route was recorded into the northwest Atlantic, off the coast of southwestern Ireland (Dobson and Madeiros 2009).

Southeast U.S. Continental Shelf Large Marine Ecosystem. First reported off North Carolina's Outer Banks in April 1983 (Lee 1987), today the species regularly occurs off the North Carolina coast (National Audubon Society 2005; White 2004).

Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf Large Marine Ecosystems. Recent data recorded during the nonbreeding season documented western routes to the Gulf Stream and northern movements to the Bay of Fundy, into the Gulf of St. Lawrence, and over the Grand Banks. An additional route was recorded off the coast of southwestern Ireland (Dobson and Madeiros 2009).

3.6.2.5.3 Population and Abundance

This extremely rare seabird is slowly but steadily increasing: 18 pairs were recorded in the year 1951; 70 pairs raising 40 young were recorded in the year 2003; and 71 pairs raising 35 young were recorded in the year 2005 (International Union for Conservation of Nature and Natural Resources 2010). The reproductive output between 2000 to 2001 and 2007 to 2008 ranged from 29 to 40 fledglings per year (Madeiros et al. 2012). Conservation efforts continue and the species is recovering in number, with the population estimated at 250 (International Union for Conservation of Nature and Natural Resources 2010). This estimate is based on 71 breeding pairs and does not include the most current December 2009 report of 96 confirmed pairs (Dobson and Madeiros 2009); 93 of these pairs fledged 52 young in the year 2010 (Dobson 2010).

3.6.2.5.4 Predator and Prey Interactions

Bermuda petrels feed mostly on squid, but their diet also consists of shrimp and small fish (National Audubon Society 2005). Specific information on the feeding behavior of Bermuda petrels is lacking, but petrels of the genus *Pterodroma* land on the ocean surface where they scavenge or grab prey; they also feed on the wing (while flying), where they are able to catch flying fish (Onley and Scofield 2007).

3.6.2.5.5 Species-Specific Threats

Current threats to this species include habitat loss; competition for nest sites with the white-tailed tropicbird (Dobson and Madeiros 2009); egg failure from contaminants (Brooke 2004; Wurster and Wingate 1968); light pollution from a nearby Bermuda airport; sea level rise; and increasing frequency and magnitude of tropical storms and hurricanes, which destroy nests through erosion, wave damage, and flooding (BirdLife International 2008, 2010a; Dobson and Madeiros 2009; Madeiros et al. 2012).

3.6.2.6 Piping Plover (*Charadrius melodus*)

The piping plover (*Charadrius melodus*) is divided into two subspecies of plovers. The piping plovers that breed on the Atlantic coast of the United States and Canada belong to the Atlantic subspecies *Charadrius melodus melodus* (U.S. Fish and Wildlife Service 2009b) and occur within the Study Area.

3.6.2.6.1 Status and Management

The U.S. Fish and Wildlife Service listed the Atlantic Coast piping plover population as threatened under the ESA in the year 1985 and has instituted a recovery plan for this shorebird species (U.S. Fish and Wildlife Service 1996). In the years 2001 and 2002, critical habitat was designated for the Great Lakes breeding population, Northern Great Plains breeding population, and for piping plovers from all three breeding populations while on the wintering grounds. Critical habitat for wintering plovers has been designated in coastal areas near or within the Study Area as shown in Figure 3.6-1 and Figure 3.6-2.

The U.S. Fish and Wildlife Service designated 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for wintering populations. This critical habitat includes 1,798.3 miles (mi.) (2,891.7 kilometers [km]) of mapped shoreline and 165,211 ac. (66,881 ha) of mapped area along the gulf and Atlantic coasts and along interior bays, inlets, and lagoons (Federal Register [FR] 66 (132): 36038-36086, July 10, 2001). The primary constituent elements of wintering piping plover habitats are those essential to foraging, sheltering, and roosting and are found in coastal areas containing intertidal beaches and flats and dunes above the annual mean high tide (FR 66 (132): 36038-36086, July 10, 2001). Any critical habitat located above the mean high tide line is outside the Study Area, as described in Section 3.0.3 (Ecological Characterization of the Study Area).

The 2004 National Defense Authorization Act allows military installations to be excluded from critical habitat designation for endangered species under the ESA provided that the Integrated Natural Resource Management Plan affords (1) a benefit to the species; (2) certainty that the management plan will be implemented; and (3) certainty that the conservation effort will be effective. On some Navy installations where piping plovers breed or overwinter, the Navy is exempt from critical habitat designations.

3.6.2.6.2 Habitat and Geographic Range

In the Study Area, the Atlantic breeding population of piping plovers nest and breed on coastal beaches from southern Maine to North Carolina and are primarily an inhabitant of sandy shorelines in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems (Haig and Elliott-Smith 2004; O'Brien et al. 2006). Piping plovers nest above the mean high tide line (outside the Study Area) on coastal beaches, sand flats at the ends of sandpits and barrier islands, gently sloping foredunes (dunes parallel to the shoreline), blowout areas behind primary dunes, and washover areas cut into or between dunes (U.S. Fish and Wildlife Service 1996). Individuals migrate through and winter in coastal areas of the United States from North Carolina to Texas and portions of Yucatan in Mexico and the Caribbean (U.S. Fish and Wildlife Service 2009a). In winter, the species is only found in coastal areas using a wide variety of habitats, including mudflats and dredge spoil areas and, most commonly, sandflats (Gratto-Trevor et al. 2012; O'Brien et al. 2006). Plovers appear to prefer sandflats adjacent to inlets or passes, sandy mudflats along spits (beaches formed by currents), and overwash areas as foraging habitats. Piping plover migration routes habitats and habitats overlap breeding and wintering habitats.

Southeast U.S. Continental Shelf Large Marine Ecosystem. Band recovery results from birds banded during the breeding season indicate that most Atlantic coast breeders winter along the southern Atlantic coast from North Carolina to Florida, although some birds have been reported to winter in Texas (Haig and Elliott-Smith 2004). Evidence suggests that most of the Great Lakes population winters south along the Atlantic coast. Both spring and fall migration routes are believed to follow the Atlantic coast (Haig and Elliott-Smith 2004).

Gulf of Mexico Large Marine Ecosystem. Evidence suggests that most of the threatened Northern Plains population winters on the gulf coast (Haig and Elliott-Smith 2004).

Caribbean Sea Large Marine Ecosystem. Islands in the Caribbean, the Bahamas and West Indies, serve as important wintering habitat (U.S. Geological Survey 2007).

3.6.2.6.3 Population and Abundance

The 1991 international census documented 5,482 total piping plover (Haig and Elliott-Smith 2004). The 2001 total population estimate was 5,945 total birds (Haig and Elliott-Smith 2004). Coastal Atlantic United States populations have trended upward since listing, though some areas' breeding populations are remaining at depressed levels and showing little or no increase in size. Since its 1985 listing, the Atlantic Coast population estimate has increased from 790 pairs to an estimated 1,849 pairs in the year 2008, and the United States portion of the population has almost tripled, from approximately 550 pairs to an estimated 1,596 pairs (U.S. Fish and Wildlife Service 2009a). Between 1989 and 2008, the largest population increase occurred in New England (245 percent), followed by New York–New Jersey (74 percent). Overall population growth was tempered by rapid declines in the Southern and Eastern Canada recovery units; the eastern Canada population decreased 21 percent (2002–2005), and the population in the southern half of the Southern recovery unit declined 68 percent (1995–2001) (U.S. Fish and Wildlife Service 2009a). Also, the Maine population declined 64 percent, from 66 pairs in the year 2002 to 24 pairs in 2008, mostly due to loss of habitat from spring storms and dune stabilization projects. Results of the 2006 international piping plover winter census showed a total of 3,355 piping plovers in the United States, with the highest counts occurring in Texas (U.S. Fish and Wildlife Service 2009a). Though the increased abundance of the Atlantic Coast plovers has reduced near-term extinction threats, geographic variation in population growth and sensitivity to survival and productivity are cause for continuing conservation concern (U.S. Fish and Wildlife Service 2009b).

3.6.2.6.4 Predator and Prey Interactions

Feeding habitats of breeding piping plovers include intertidal portions of ocean beaches, washover areas, mudflats, sandflats, wrack lines (line of deposited seaweed on the beach), shorelines of coastal ponds, lagoons, and salt marshes (Gratto-Trevor et al. 2012; U.S. Fish and Wildlife Service 1996). They hunt visually using a start-and-stop running method, gleaning and probing prey from the substrate for a variety of small invertebrates (marine worms, crustaceans, molluscs, insects, and the eggs and larvae of many marine invertebrates) (Maslo et al. 2012; U.S. Fish and Wildlife Service 1996). Foraging occurs throughout the day and at night.

Piping plovers are preyed upon by various species. These predators, such as raccoons, foxes, skunks, and domestic and feral cats, are often associated with developed beaches and have been identified as a substantial source of mortality for piping plover eggs and chicks (U.S. Fish and Wildlife Service 2009b; Winter and Wallace 2006).

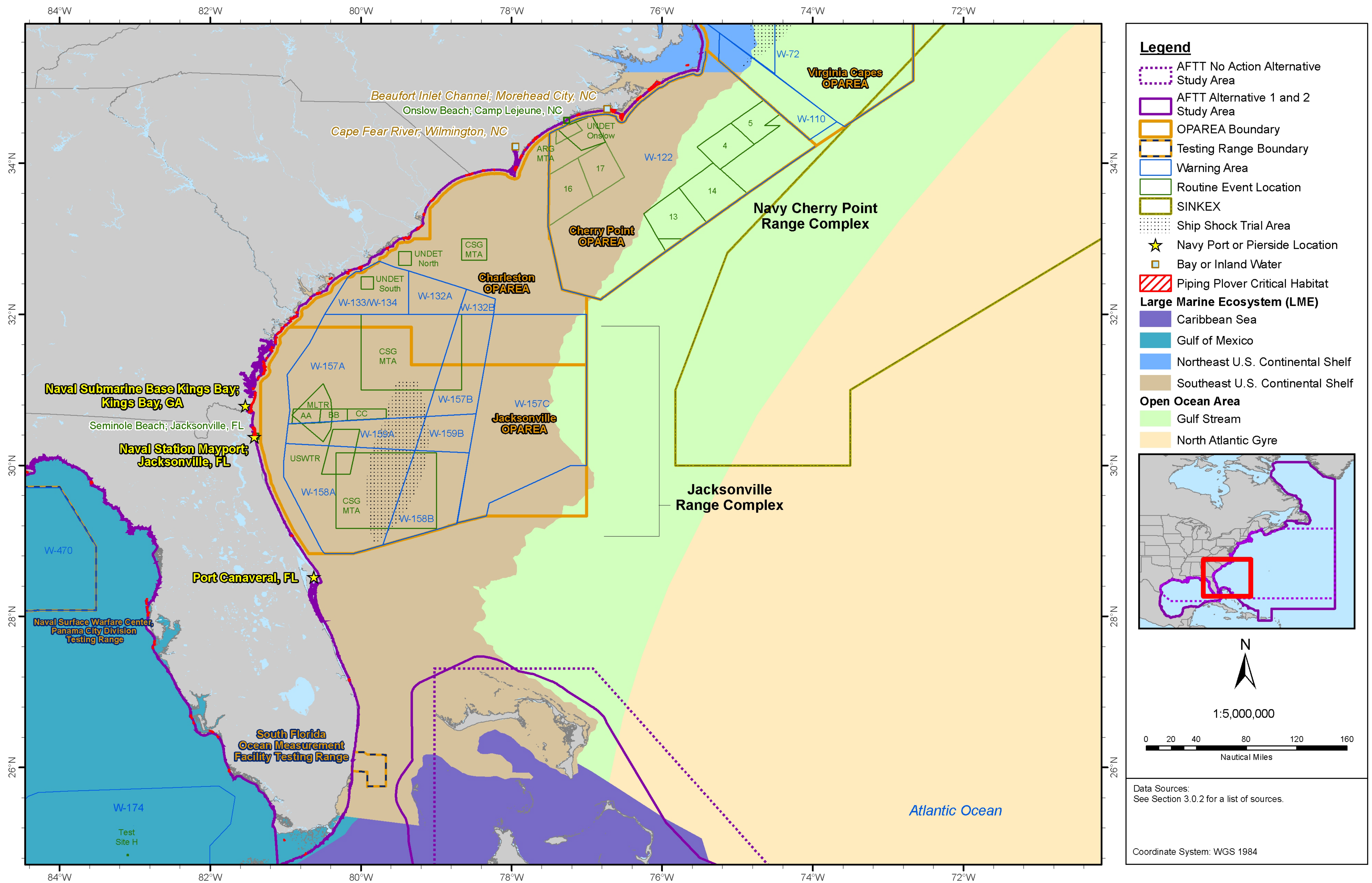

Figure 3.6-1: Critical Habitat Areas for Piping Plover in and Adjacent to the Atlantic Coastal Portions of the Study Area

AFTT: Atlantic Fleet Training and Testing; ARG MTA: Amphibious Readiness Group Mine Training Area; CSG MTA: Carrier Strike Group Mine Training Area; FL: Florida; GA: Georgia; MLTR: Missile Laser Training Range; NC: North Carolina; OPAREA: Operating Area; SINKEX: Sinking Exercise; UNDET: Underwater Detonation; USWTR: Undersea Warfare Training Range

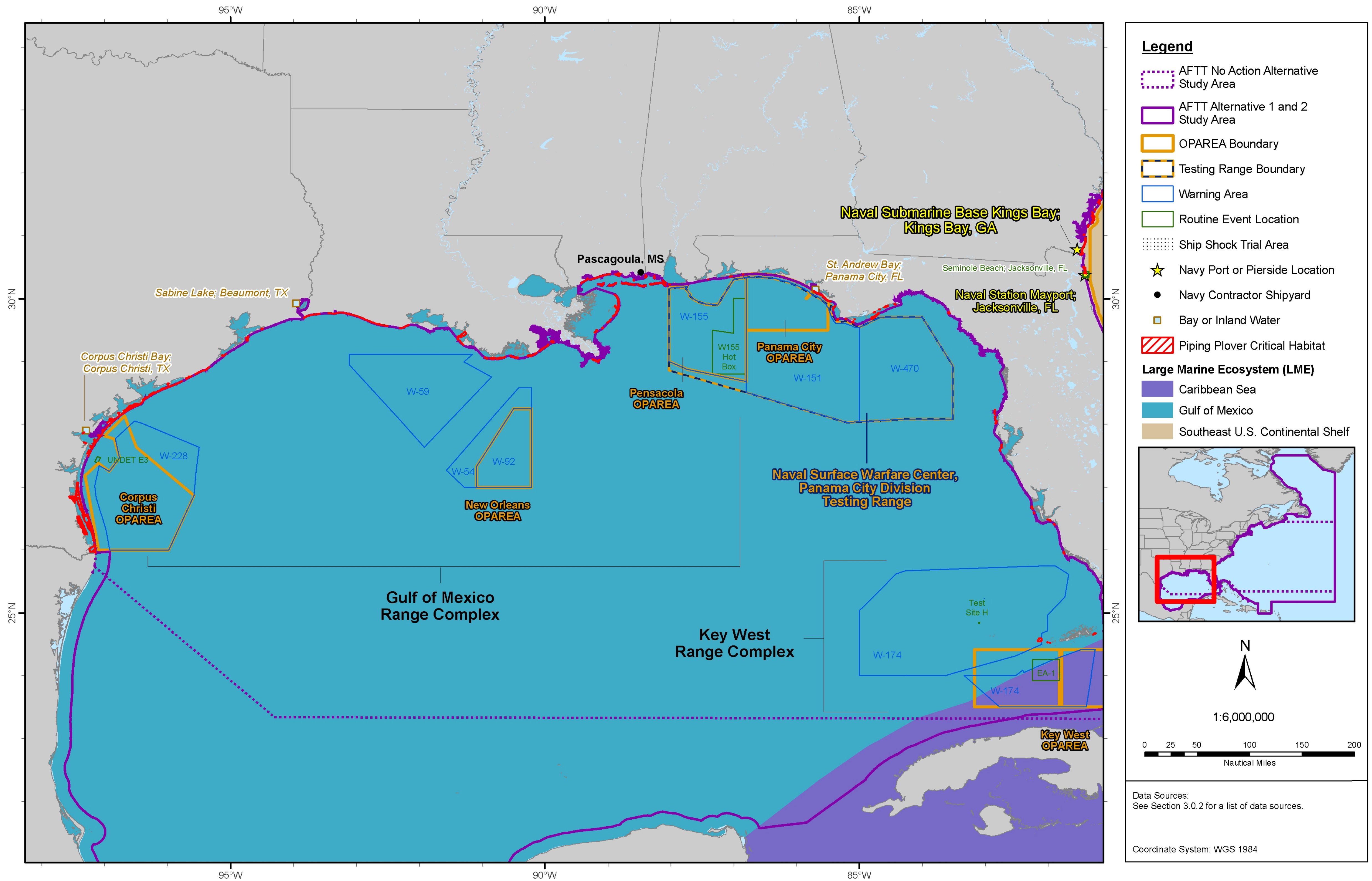

Figure 3.6-2: Critical Habitat Areas for Piping Plover in and Adjacent to the Gulf of Mexico Coastal Portions of the Study Area

AFTT: Atlantic Fleet Training and Testing; FL: Florida; GA: Georgia; MS: Mississippi; OPAREA: Operating Area; TX: Texas; UNDET: Underwater Detonation

3.6.2.6.5 Species-Specific Threats

The localized declines of the Atlantic coast piping plover population is attributed to habitat loss and degradation and increased predator populations in coastal environments (U.S. Fish and Wildlife Service 1996). Excessive disturbance may cause the parents to flee the nest, exposing eggs or chicks to the hot sun or predators. High disturbance levels around nest sites can also result in the abandonment of nests and, ultimately, decreased breeding success (Cohen and Gratto-Trevor 2011). Causing parents or juveniles to flush while foraging may stress juveniles enough to negatively influence critical growth and development. Few areas used by wintering piping plovers are free of human disturbance, and nearly 50 percent have leashed and unleashed dog presence (U.S. Fish and Wildlife Service 2009b).

Along the Atlantic coast, commercial, residential, and recreational development have decreased the amount of coastal habitat available for piping plovers. Trends show continued loss and degradation of habitat in migration and wintering areas due to sand placement projects, inlet stabilization, sand mining, erosion prevention structures (groins, seawalls, and revetments, exotic and invasive vegetation, and wrack removal (U.S. Fish and Wildlife Service 2009b). Unusual events, such as hurricanes, can impact hundreds of young-of-the-year and adults. Storms can also, over time, positively impact local piping plover populations by leveling dunes and creating suitable nesting habitat (U.S. Fish and Wildlife Service 1996). Beach development and stabilization activities, dredging, recreational activities, and pollution are factors that impact the plover population on wintering grounds (U.S. Fish and Wildlife Service 1996). There are also unknown sources of mortality experienced during migration or on the wintering grounds (Calvert et al. 2006; Root et al. 1992). Recent data suggest that lighting on vessels and on offshore oil and gas platforms may cause mortality and could help explain some of these unknown mortality events (Merkel and Johansen 2011). New potential threats include wind turbine development projects which introduce the possibility of collision, disturbance, and displacement of plovers (Burger et al. 2011). Another threat is climate change resulting in sea level rise that would directly impact Atlantic coast piping plovers breeding and wintering habitat (U.S. Fish and Wildlife Service 2009b).

3.6.2.7 Roseate Tern (*Sterna dougallii*)

Five subspecies of the roseate tern have been described, though some taxonomic designations are uncertain: *S. dougallii dougallii* in the North Atlantic, Europe, and the Caribbean; *S. dougallii korustes* in India, Sri Lanka, and Burma; *S. dougallii gracilis* in Australia and Indonesia; and *S. dougallii arideensis* on the Seychelles Islands (Gochfeld et al. 1998). All subspecies are similar in appearance to *S. dougallii dougallii*, with slight differences in wing length and bill color. The North Atlantic and Caribbean population of *S. dougallii dougallii* is the subspecies that occurs within the Study Area (U.S. Fish and Wildlife Service 2010a).

3.6.2.7.1 Status and Management

In the year 1987, the U.S. Fish and Wildlife Service listed the roseate tern as endangered under the ESA along the Atlantic coast of the United States (Maine to North Carolina); in Canadian provinces of Newfoundland, Nova Scotia, and Quebec, as well as in Bermuda (U.S. Fish and Wildlife Service 2010e). The species is listed as threatened under the ESA in the Western Hemisphere, including Florida, Puerto Rico, and the Virgin Islands (U.S. Fish and Wildlife Service 2010e). No critical habitat has been designated for this species in the United States. In the year 2006, Canada designated critical habitat for the species (U.S. Fish and Wildlife Service 2010a). Recovery and management plans have been implemented to protect breeding colonies, foraging areas, and wintering grounds (Gochfeld et al. 1998). The plans intend to increase breeding population size, distribution, and productivity by maintaining, expanding, and enhancing nesting habitat (U.S. Fish and Wildlife Service 1998). Recovery and management methods include posting nesting areas with signs and fencing, discouraging and controlling competing gull species, managing vegetation to enhance nesting habitat, and attempting to attract individuals to historically occupied sites (U.S. Fish and Wildlife Service 1998).

3.6.2.7.2 Habitat and Geographic Range

Roseate terns arrive at their breeding grounds in late April and early May (early to mid-May in the Caribbean population) and spend approximately 2 weeks feeding before they occupy nesting grounds (U.S. Fish and Wildlife Service 1998). They migrate in late August and early September, traveling in groups to wintering grounds along the northern and eastern South American coast (Gochfeld et al. 1998; Kirkham and Nettleship 1987; U.S. Fish and Wildlife Service 1998). Their migration route is believed to traverse directly south across the western North Atlantic (U.S. Fish and Wildlife Service 1998). Local commutes of up to 16 mi. (25 km) from nesting grounds to dependable foraging sites have been documented (Nisbet and Spendelow 1999).

There is little information on migration and winter habitat for the roseate tern (Nisbet and Spendelow 1999; U.S. Fish and Wildlife Service 1993). Caribbean roseate terns may mingle with the northeastern birds in South American waters during the winter (U.S. Fish and Wildlife Service 1993).

Roseate terns are colonial breeders, and both the North Atlantic and Caribbean populations are known to nest on a limited number of small islands off New York and Massachusetts (Gochfeld et al. 1998). They nest on islands near or under cover, such as vegetation, rocks, driftwood, and even human-made objects. They have also been documented nesting on sand dunes found at the end of barrier beaches (U.S. Fish and Wildlife Service 1998). North American roseate terns use moderately to heavily vegetated sites for nesting (Burger and Gochfeld 1988). Unlike the northeastern population, Caribbean roseate tern nests are exposed. Nests are near vegetation or rocks, on open sandy beaches, narrow rock ledges close to the water line, or among coral rubble (U.S. Fish and Wildlife Service 1993).

Open Ocean. Within the Study Area, North American roseate terns occur throughout the open ocean (Gulf Stream and North Atlantic Gyre) more often during the winter than during the breeding season (U.S. Fish and Wildlife Service 1999).

Northeast U.S. Continental Shelf Large Marine Ecosystem. Most breeding North American roseate terns occur in this large marine ecosystem from late April/early May to late August/early September (Table 3.6-1). Approximately 80 percent of the northeast population breeds at two large colonies on Great Gull Island, New York; and Bird Island, Massachusetts; with the remaining percentage breeding at 15–20 smaller colonies in Canada and the United States (Connecticut, Massachusetts, Maine, and New York) (Gochfeld et al. 1998). Sand flats and beaches of southeastern Massachusetts, particularly along outer Cape Cod and nearshore islands provide important roosting and loafing habitats during fall staging. The Nantucket Shoal between the Massachusetts mainland and the islands of Martha's Vineyard and Nantucket is a particularly important foraging area for the entire northeastern population (U.S. Fish and Wildlife Service 2010a).

Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea Large Marine Ecosystems. Wintering North American roseate terns occur along the southeast Atlantic and gulf coasts (U.S. Fish and Wildlife Service 2010e). The Caribbean population of roseate tern breeds from the Florida Keys through the West Indies to islands off Central America and northern South America (U.S. Fish and Wildlife Service 1993). Within the Study Area, the Gulf of Mexico and Caribbean Sea Large Marine Ecosystems contain the population in the Florida Keys and Dry Tortugas, and Puerto Rico.

3.6.2.7.3 Population and Abundance

The estimated global population of roseate terns is approximately 70,000 to 82,000 (BirdLife International 2010b). They are a widespread species that breed on every continent except Antarctica, with populations in the Indian Ocean, Caribbean, Australasian, European, African, and North American regions (Gochfeld 1983). The roseate tern populations in North America and the Caribbean are estimated at around 10,000 pairs (Gochfeld 1983). Approximately 2,500 pairs are estimated in the northeast U.S. population, with an additional 125 pairs in Canada and 350 pairs in Florida, which is a reduction of almost 25 percent since the year 2000 (U.S. Fish and Wildlife Service 2010a). The roseate tern experienced drastic declines in the late nineteenth century due to commercial hunting of feathers for the millinery (hat-making) industry (U.S. Fish and Wildlife Service 1998), as well as humans seeking eggs for food (Kirkham and Nettleship 1987). Populations again showed decline in the 1940s and 1970s as the geographic range and the number of breeding colonies decreased (U.S. Fish and Wildlife Service 1998).

Groups of roseate terns can be small due to their limited population size and limited nesting habitat in North America. In the northeast, breeding colonies of roseate terns range from 2 to more than 1,000 pairs, depending on breeding colony location (U.S. Fish and Wildlife Service 1998). After chicks fledge from their breeding colonies, terns tend to congregate in large numbers at post-breeding staging areas to build up energy reserves for their seasonal fall migration to South America (U.S. Fish and Wildlife Service 2010a). Northeastern roseate terns are always mixed with gulls and other species of terns, while populations in the Caribbean and the Seychelles Islands are known to form single-species colonies (Gochfeld et al. 1998). Duffy (1986) found that roseate terns foraging in smaller flocks experienced higher survival rates, while in larger groups they were often out-competed by common terns.

3.6.2.7.4 Predator and Prey Interactions

The roseate tern is a coastal species that forages for small schooling fishes over shallow waters around bays, channels, sandbars, shoals, and reefs (Gochfeld et al. 1998; Nisbet and Spendelow 1999). They are also known to forage out over deeper waters than other tern species (Olsen and Larsson 1995). Roseate terns generally concentrate in areas where prey is available close to the surface, driven there either by water movements or larger predatory fish.

Roseate terns are specialized aerial plunge-divers that often completely submerge themselves when seizing fish (U.S. Fish and Wildlife Service 2010e). Roseate terns tend to plunge from heights above the water's surface ranging from 3 to 20 ft. (1 to 6 m), although plunges from greater than 39 ft. (12 m) have been observed (Gochfeld et al. 1998). Roseate terns do not plunge deep into the water column, usually up to 3 ft. (1 m). Roseate terns will often fly into the wind and hover (a behavior known as "kiting") with rapid wingbeats and then, with accelerated flapping, aerial plunge into the water (Kaufman 1990; U.S. Fish and Wildlife Service 1998, 1999). Prey species are herring, mackerel, anchovies, and sand eels (Gochfeld et al. 1998).

Roseate tern eggs and young are preyed upon by hermit and land crabs, ants, snakes, other birds (e.g., hawks, owls, gulls, and some shorebirds), and mammals such as rats and feral cats (U.S. Fish and Wildlife Service 1993).

3.6.2.7.5 Species-Specific Threats

Roseate tern population declines have been attributed to commercial hunting and egg collection, habitat loss and disturbance, organochlorine contamination, predation, and competition from gulls (U.S. Fish and Wildlife Service 1998). These threats, combined with the small number of breeding sites used by the species, warranted the listing of the species (Nisbet and Spendelow 1999). Roseate terns are sensitive to disturbance on their nesting grounds, and many suitable nesting sites have been lost or abandoned due to the expansion of recreational, residential, and commercial use (Gochfeld 1983). Beach erosion and the expansion of gull populations have also displaced roseate terns from suitable nesting habitat (Gochfeld et al. 1998). Roseate terns are vulnerable to predation and flooding because they nest on the ground, often in low-lying areas (Gochfeld 1983). Storms and prolonged periods of cold, wet weather also impact nest success (U.S. Fish and Wildlife Service 1993). Climate change and sea level rise may exacerbate erosion of nesting grounds and could result in more severe or more frequent storms, which could disturb these habitats and result in reduced survival of adults, eggs, chicks, and fledglings (U.S. Fish and Wildlife Service 2010a). Starvation is likely a greater cause of death during the winter in areas such as the southern Caribbean where nutrients are relatively poor (Gochfeld 1983). Although little is known about roseate tern ecology during migration and wintering periods, one major cause of death is believed to be humans hunting this species on its wintering grounds (outside the United States) (Gochfeld et al. 1998). Emerging potential threats include wind turbine development projects which introduce the possibility of collision, disturbance, and displacement of this species during the breeding and migratory seasons (Burger et al. 2011).

3.6.2.8 Red Knot (*Calidris canutus rufa*)

Red knots (*Calidris canutus*) found on the Atlantic coast of the United States and Canada belong to the subspecies *C. canutus rufa* (Harrington 2001). This subspecies of red knot was designated as a candidate species for listing under the ESA 2006 (Niles et al. 2008); as of 2012 the species was considered for proposed listing by the U.S. Fish and Wildlife Service (FR 77 (225): 69994-70060, November 21, 2012).

3.6.2.8.1 Status and Management

Four petitions to emergency list the red knot have been submitted since 2004; however, the species currently remains listed as a candidate for protection under the ESA (U.S. Fish and Wildlife Service 2010d). A candidate species is one in which there is sufficient information to make a listing, but the listing is precluded by higher priorities. Although candidate species do not receive statutory protection under the ESA, conservation partnerships are encouraged because the species may be listed in the future (U.S. Fish and Wildlife Service 2002). Based on a recommendation from the U.S. Fish and Wildlife Service to include the candidate red knot in the current consultation and because a listing determination on the red knot is anticipated in the near future, the Navy has made an effect determination for this species as if it was already listed under the ESA (FR 77 (225): 69994-70060, November 21, 2012). The five-year goal highlighted in the species action plan is to stabilize and improve the conservation status of the species through increasing habitat protection, reducing disturbance, and protecting key resources at migration and wintering sites (Harrington 2001; U.S. Fish and Wildlife Service 2010d). The Western Hemisphere Shorebird Reserve Network has established an international network of wetlands in an effort to protect important sites used by shorebirds, including the red knot (Tsipoura and Burger 1999).

3.6.2.8.2 Habitat and Geographic Range

The species breeds on the central Canadian arctic tundra but migrates down and winters along the Atlantic and gulf coasts from southern New England to Florida, and as far south as South America (Harrington 2001). Red knots will briefly use important stopover areas such as the Delaware Bay to forage before returning to their breeding grounds each year. An interior red knot population winters in Texas and Louisiana and migrates through the west and midwest to central Canada.

Open Ocean Areas. Red knots migrate some of the longest distances known for birds, with many individuals annually flying more than 9,300 mi. (15,000 km) (U.S. Fish and Wildlife Service 2005), during which they may cross over each of the open ocean areas in the Study Area. However, outside of migration they are typically found in nearshore habitats along coastlines. Fall migration peaks in August with birds flying south along the Atlantic coast to major wintering grounds on the coasts of Argentina and southern Chile (Harrington 2001).

Northeast U.S. Continental Shelf Large Marine Ecosystem. During migration stopovers, the red knot uses marine habitats and generally prefers coastal, sandy habitats near tidal bays, inlets, and estuaries for foraging (Harrington 2001). Red knots migrate in large flocks and stop over at the same coastal sites along the Atlantic coast during spring migration to feed on eggs of horseshoe crabs (*Limulus polyphemus*). In particular, Delaware Bay is one of the largest known spring (mid-May to early June) stopover sites for this species (FR 71 (176): 53756-53835, September 12, 2006; (Clark et al. 1993). Up to 80 percent of the entire estimated red knot population has been observed at once in the Delaware Bay during spring migration, leading to the area being designated as the first hemispheric site in the Western Hemisphere Shorebird Reserve Network (Clark et al. 1993; Tsipoura and Burger 1999) (Niles et al. 2008).

Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems. During fall and spring migration and winter months, red knots occur in nearshore coastal habitats, along the Atlantic and gulf coasts from southern New England to Florida and into the Gulf of Mexico (Harrington 2001). The Virginia Atlantic barrier islands are a second major stopover location, with red knot peak counts between 5,500 and 9,100 birds since 1995 (Niles et al. 2008). They primarily occur in intertidal surf-zone habitats, particularly near coastal inlets, estuaries, and bays.

3.6.2.8.3 Population and Abundance

The red knot population was previously estimated at 100,000 to 150,000 individuals in the 1980s (Niles et al. 2008). However, annual aerial and ground surveys of Delaware Bay show fluctuation but generally a downward trend. Population surveys during the stopover period in the spring of 1998 at Delaware Bay estimated 50,000 red knots. In the year 2004, the same survey was repeated and the estimated population was substantially lower at 18,000 (Niles et al. 2008). Surveys of red knots at both migration stopover sites and wintering grounds continually show substantial population declines in recent decades (FR 71 (176): 53756-53835, September 12, 2006). For example, surveys during the mid-1980s of wintering red knot populations in South America (Argentina and Chile) provided an estimate of 67,500 individuals (Niles et al. 2008); but according to USFWS, since the year 2005, numbers have been under 20,000 birds, and dipped below 10,000 in the year 2011. Studies from 1994 to 2002 also show decreased annual adult survival rates related to these population declines (Niles et al. 2008).

3.6.2.8.4 Predator and Prey Interactions

Red knots forage by surface pecking and probing for intertidal invertebrates and various species of mussels and other molluscs (Harrington 2001). During spring migration, a major food source for red knots are horseshoe crab eggs; millions of which can be found in the Delaware Bay during the second half of May (Botton et al. 1994). Red knot migration coincides with the horseshoe crabs laying their eggs, allowing birds to restore their fat reserves to continue their northward migration to their breeding grounds in the arctic (Harrington 2001; Tsipoura and Burger 1999).

Outside of the breeding grounds, red knot predators include peregrine falcon (*Falco peregrinus*), merlin (*Falco columbarius*), northern harrier (*Circus cyaneus*), short-eared owl (*Asio flammeus*), great black-backed gull (*Larus marinus*), and accipiters (goshawks and sparrow hawks) (Niles et al. 2008). Predators on breeding grounds include arctic fox (*Alopex lagopus*), long-tailed jaeger (*Stercorarius longicaudus*), and parasitic jaeger (*Stercorarius parasiticus*) (Piersma et al. 1993).

3.6.2.8.5 Species-Specific Threats

The red knot is threatened under the ESA mainly by habitat loss and degradation of foraging resources such as reduction of horseshoe crab populations (U.S. Fish and Wildlife Service 2010d). Harvesting of horseshoe crab eggs for bait in the conch and eel fishing industries as well as research in the biomedical industry are believed to have caused a reduction in the amount of eggs available for red knots especially in Delaware Bay, causing lower weight gain during migratory stopovers and contributing to lower adult survival (Niles et al. 2008). Beach erosion, shoreline protection and stabilization projects, human disturbance, limited food resources, oil spills, red tides, hunting, and severe weather all threaten the stability of the population (Niles et al. 2008; U.S. Fish and Wildlife Service 2010d). Because large percentages of the entire population gather at single sites during migration (i.e., Delaware Bay) and winter, the species is especially vulnerable to loss of key resources at these sites (Clark et al. 1993; Harrington 2001; Niles et al. 2008).

Sections 3.6.2.9 (Geese, Swans, Dabbling and Diving Ducks [Order Anseriformes]) through 3.6.2.18 (Neotropical Migrant Songbirds, Thrushes, Allies, Cuckoos, Swifts, and Owls [Orders Passeriformes, Cuculiformes, and Apodiformes]) describe the taxonomic groups of non ESA-listed bird species in the Study Area. There are 386 bird species defined as neotropical migrants under the Neotropical Migratory Bird Conservation Act, of which 185 could occur in the Study Area during the spring and fall migration period.

3.6.2.9 Geese, Swans, Dabbling and Diving Ducks (Order Anseriformes)

There are 50 species of swans, geese, and dabbling and diving ducks in the family Anatidae in North America. No birds from this group are considered Birds of Conservation Concern (U.S. Fish and Wildlife Service 2008). Birds from this group range from dabbling ducks found in coastal bays, estuaries, and lagoons to more open water ducks found in deeper water environments. Twenty-three of these species are diving ducks that inhabit nearshore or offshore waters of the Study Area (Sibley 2007). Scaups, eiders scoters, long-tailed duck (*Clangula hyemalis*), and harlequin duck (*Histrionicus histrionicus*) are some diving ducks that winter in nearshore ocean waters. All these divers can be found in deeper water where they dive for food (Sibley 2007), some also forage on the ocean bottom in shallow water. Most duck species dive down to 33 ft. (10 m) but long-tail ducks have been reported to dive down to 218 ft. (66 m) with a dive time of around 35 seconds (s) (Sibley 2007). Some inshore shark species, as well as alligators and crocodiles, prey on ducks on the surface of the water (Ehrlich et al. 1988).

The harlequin duck is small and agile and prefers very turbulent water in streams during the breeding season. Their winter habitat includes coastal intertidal areas, but they roost at night on open water farther offshore (greater than 0.6 mi. [1 km]) (Robertson and Goudie 1999). The long-tailed duck winters in small groups in shallow ocean habitat.

Representative species that can be found in coastal bays, estuaries, and lagoons include geese (e.g., Canada goose [*Branta canadensis*], brant [*Branta bernicla*]); swans (e.g., trumpeter swan [*Cygnus buccinators*], tundra swan [*Cygnus columbianus*]); dabbling ducks (e.g., mallard [*Anas platyrhynchos*], gadwall [*Anas strepera*], mottled duck [*Anas fulvigula*], American black duck [*Anas rubripes*], American wigeon [*Anas americana*], northern shoveler [*Anas clypeata*], blue-winged teal [*Anas discors*], and green-winged teal [*Anas crecca*]); diving ducks (e.g., redhead [*Aythya americana*], bufflehead [*Bucephala albeola*], common goldeneye [*Bucephala clangula*], and red-breasted merganser [*Mergus serrator*]); eiders (e.g., common eider [*Somateria mollissima*], king eider [*Somateria spectabilis*]; and scoters (e.g., surf scoter [*Melanitta perspicillata*], black scoter [*Melanitta americana*]) (American Ornithologists' Union 1998).

3.6.2.10 Loons (Order Gaviiformes)

There are five species of loons in the family Gaviidae in North America (American Ornithologists' Union 1998), three of which occur in the Study Area. The common loon (*G. immer*) is a Bird of Conservation Concern (U.S. Fish and Wildlife Service 2008). Loons are medium to large fish-eating birds that capture prey by diving underwater (Sibley 2007). Loons can dive down to 250 ft. (76 m) with an average dive time of 40 s (Sibley 2007). Loons move ashore only to breed, and all loon species nest on banks of inland ponds or lakes, requiring specific habitat features such as undeveloped shoreline and nest sites that have steep drop offs so they can approach their nest from underwater (Cornell Lab of Ornithology 2009a). For example, common loons spend their time in both freshwater and saltwater environments but prefer to nest on islands where the shoreline is not developed. Most loons need about 100 ft. (30.5 m) of room to take off, so size is another habitat feature that is important for nesting areas. During migration, loons fly high above land or water in loose groups or singly. They winter in coastal, nearshore, or open water marine habitats (Sibley 2007). For example, the Pacific loon (*G. pacifica*) prefers deep water and is found on the open ocean and in bays. One representative species within the Study Area are the red-throated loon which has a circumpolar distribution, breeds in high latitudes on remote ponds, and winters along the Atlantic and Pacific coasts (American Ornithologists' Union 1998).

3.6.2.11 Grebes (Order Podicipediformes)

There are seven species of grebes in the family Podicipedidae in North America (American Ornithologists' Union 1998). Two of these species, the pied-billed grebe (*Podilymbus podiceps*) and horned grebe (*Podiceps auritus*) are Birds of Conservation Concern (U.S. Fish and Wildlife Service 2008). Grebes forage by diving for small aquatic animals such as insects, fish, and crustaceans in the water column. For example, horned grebes can dive for up to 3 minutes and travel 500 ft. (152 m) underwater, where they are sometimes preyed upon by sharks and orcas (Ehrlich et al. 1988). Grebes tend to escape predators by diving or sinking, leaving only the head exposed, rather than taking flight. All grebe species build floating nests in marshes and winter on the ocean and nearshore coastal areas (Sibley 2007).

3.6.2.12 Albatrosses, Fulmars, Petrels, Shearwaters, and Storm-Petrels (Order Procellariiformes)

Procellariiformes is a large order of pelagic seabirds that are divided into four families: Diomedeidae (albatrosses), Procellariidae (petrels and shearwaters), Hydrobatidae (storm-petrels), and Pelecanoididae (diving-petrels) (Enticott and Tipling 1997; Onley and Scofield 2007). This order includes species that are generally long lived, breed once a year, and lay only one egg; thus, they have a low reproductive output. One of these species is endangered under the ESA (Section 3.6.2.5, Bermuda Petrel [*Pterodroma cahow*]) (U.S. Fish and Wildlife Service 2010b) and four are Birds of Conservation Concern as shown in Table 3.6-3 (U.S. Fish and Wildlife Service 2008).

Many seabirds spend most of their lives at sea and come to land only to breed, nest, and occasionally roost (Schreiber and Chovan 1986). Colonial breeding is believed to have evolved in response to the limited availability of relatively predator-free nesting habitats and distance to foraging sites from breeding grounds (Siegel-Causey and Kharitonov 1990). Benefits of colonial breeding include increased detection of predators and decreased chance of predation of young while parent birds are foraging away from the nest (Gill 1995).

Seabirds can be found in high numbers resting on the water surface in flocks where prey is concentrated (Enticott and Tipling 1997). Some species are found around fishing boats, where they often feed on bycatch and may become injured from longline gear (Enticott and Tipling 1997; Onley and Scofield 2007). Also, because of their pelagic nature, this group is preyed on by some pelagic shark species (Ehrlich et al. 1988). Oceanic fronts (gradients in current speed, temperature, salinity, density, and enhanced circulation) attract seabirds due to increased foraging opportunities. For example, the at-sea distribution of some seabirds is associated with oceanic fronts, which support increased numbers of prey and provide favorable foraging conditions (Bost et al. 2009).

There are 20 species of Procellariiformes in North America, with 13 species representing two families—the storm-petrels and petrels and shearwaters (American Ornithologists' Union 1998)—occurring within the Study Area. Most of the petrel species in the Study Area are not considered part of the diving petrels and forage along the surface of the ocean. Petrels are colonial nesters and tend to nest on remote islands uninhabited by people.

Storm-petrels pick prey off the surface while foraging. Most breed in natural holes/cryptic burrows and visit their colonies only at night (Enticott and Tipling 1997; Onley and Scofield 2007). Fulmarine petrels, such as the northern fulmar (*Fulmarus glacialis*) and the black-capped petrel (*Pterodroma hasitata*), feed by landing on the sea and grabbing prey near the surface. Most fulmarine petrels nest in burrows or on cliff ledges and visit nests by day (Enticott and Tipling 1997; Onley and Scofield 2007). Gadfly petrels are generally species of the *Pterodroma* genus and are long-winged, fast-flying, and highly pelagic. They feed on the wing and land on the sea (Onley and Scofield 2007). Some gadfly petrels nest in burrows or crevices and visit colonies at night (Enticott and Tipling 1997; Onley and Scofield 2007).

Shearwaters are small- to medium-sized and dive to varying depths for prey (Onley and Scofield 2007). For example, Cory's shearwater (*Calonectris diomedea*) rarely dives to 16 ft. (5 m) below the surface, while sooty (*Puffinus griseus*) and short-tailed shearwaters (*Puffinus tenuirostris*) can reach depths of 230 ft. (70 m), swimming underwater with half-open wings (Enticott and Tipling 1997; Onley and Scofield 2007). Greater shearwaters in the South Atlantic Ocean have been reported to dive down to 62 ft. (19 m) and as long as 40 s in a single dive. However, the majority of their dives were less than 6.6 ft. (2 m) (Ronconi et al. 2010).

3.6.2.13 Tropicbirds, Boobies, Gannets, Pelicans, Cormorants, and Frigatebirds (Order Pelecaniformes)

The Pelecaniformes order is a diverse group of large seabirds including anhingas, pelicans, gannets, boobies, tropicbirds, cormorants, and frigatebirds. This order is composed of 17 species in six families—12 species representing five families (American Ornithologists' Union 1998) that occur within the Study Area. Three of these species are considered Birds of Conservation Concern (U.S. Fish and Wildlife Service 2008). Species of concern within the Study Area include the brown booby (*Sula leucogaster*), great cormorant (*Phalacrocorax carbo*), and magnificent frigatebird (*Fregata magnificens*) (American Ornithologists' Union 1998).

Pelecaniformes are less pelagic than the Procellariiformes, although some of these species such as tropicbirds and frigatebirds are pelagic. Most species are colonial, feed on fish, and use a variety of breeding habitats including trees and bushes (but not burrows). Breeding strategies vary among species, with some being long-lived and having low breeding success, while others have higher annual breeding success, but higher annual adult death (Enticott and Tipling 1997; Onley and Scofield 2007).

Cormorants are voracious predators on inshore fishes and have been implicated as a major threat to the recovery efforts of Atlantic salmon in the Gulf of Maine where they feed on juvenile salmon (smolts) leaving the estuaries (Fay et al. 2006; National Marine Fisheries Service and U.S. Fish and Wildlife Service 2005). Their offshore foraging range is limited by their need for undisturbed, dry nocturnal roosting sites (Shields 2002). The brown pelican (*Pelecanus occidentalis*) primarily occurs in shallow (less than 150 ft. [46 m]) warm coastal marine and estuarine environments, as well as offshore where they forage primarily on fish by head first plunge-diving. Most plunge-diving is limited to 3.5 to 6.5 ft. (1 to 2 m) within the water column. Foraging occurs within 12 mi. (20 km) of nesting islands during the breeding season, and up to 47 mi. (75 km) offshore during the nonbreeding season (Shields 2002). American white pelicans (*Pelecanus erythrorhynchos*) are found in shallow coastal bays, inlets, and estuaries that support forage fish (Knopf and Evans 2004). Flocks forage cooperatively, swimming and encircling fish as a coordinated group or driving them into shallows, where they are caught with synchronized bill dipping (Enticott and Tipling 1997; Onley and Scofield 2007).

3.6.2.14 Herons, Egrets, Ibis, Spoonbills (Order Ciconiiformes)

Ciconiiformes is a large group composed of long-legged, large billed species that includes herons, egrets, ibis, and spoonbills. This order includes 21 species represented in four families—12 species representing two families (American Ornithologists' Union 1998) occur within the Study Area. The roseate spoonbill (*Platalea ajaja*), reddish egret (*Egretta rufescens*), and snowy egret (*Egretta thula*) are the three species from this group considered Birds of Conservation Concern (U.S. Fish and Wildlife Service 2008).

They are commonly known as wading birds, and many of the species are totally dependent on water for many or all portions of their life cycle including feeding, breeding, and sheltering. Majority of these species are communal breeders and build nests within mixed-species colonies. These wading birds forage in intertidal areas by picking and probing for small aquatic prey (Sibley 2007). Though most of their life cycle is spent in coastal areas, migration over offshore areas does occur (Elphick 2007). Nearly all species of Ciconiiformes have suffered great reductions in numbers over the last century as habitat destruction of wetlands continues (American Ornithologists' Union 1998).

Representative species within the Study Area include the great blue heron (*Ardea herodias*), great egret (*Ardea alba*), little blue heron (*Egretta caerulea*), tricolored heron (*Egretta tricolor*), black-crowned night heron (*Nycticorax nycticorax*), yellow-crowned night heron (*Nyctanassa violacea*), white ibis (*Eudocimus albus*), scarlet ibis (*Eudocimus ruber*), glossy ibis (*Plegadis falcinellus*), and roseate spoonbill (American Ornithologists' Union 1998).

3.6.2.15 Flamingos (Order Phoenicopteriformes)

Flamingos are gregarious (social) wading birds in the genus *Phoenicopterus*, and the only genus in the family Phoenicopteridae. The American flamingo (*Phoenicopterus ruber)* species is found in the Study Area. The distribution range of the flamingo is extremely large and includes many Caribbean and South American countries. However, their occurrence in the United States is limited to the southern tip of Florida (Everglades National Park) (Sibley 2007; Stevens and Pickett 1994).

These wading birds forage in intertidal areas by picking and probing for small aquatic prey (Sibley 2003). Though most of their life cycle is spent along coastal areas, migration over offshore areas does occur (Elphick 2007).

3.6.2.16 Osprey, Bald Eagles, and Kites (Orders Accipitriformes and Falconiformes)

Accipitriformes is a large group consisting of 60 species in three families (American Ornithologists' Union 1998). This order generally has broad wings well-suited for soaring. Accipitriformes hunt by day and feed on a variety of prey, including fish, small mammals, reptiles, and carrion. A variety of raptor species from small falcons to large eagles could occur within the Study Area: the osprey (*Pandion haliaetus),* bald eagle (*Haliaeetus leucocephalus*), peregrine falcon, and swallow-tailed kite (*Elanoides forficatus*) are an example of some species likely to occur more frequently than other raptor species in the Study Area. The bald eagle, peregrine falcon, and swallow-tailed kite are Birds of Conservation Concern

Ospreys live near slow-moving waters of coastal, nearshore, and freshwater environments in many parts of the Study Area. Fish make up a large portion of their diet, and therefore, their vision is well adapted to detecting underwater objects from 33–131 ft. (10–40 m) above water (Poole et al. 2002). Osprey migrate from northern latitudes to southern latitudes twice a year and cross bodies of open ocean to reach their destinations (Lott 2006).

Bald eagles nest, forage, and winter along the Atlantic coast especially in the Chesapeake Bay region. Bald eagles have steadily increased since the ban on DDT from 60 pairs in the 1970s to 646 in the year 2001. The Chesapeake Bay is very important to bald eagles because it is a convergence point for all three geographically distinct populations (northeast, southeast, and Chesapeake Bay) and has played an important part in the recovery of eagles (Watts et al. 2007). Bald eagles are opportunistic feeders that generally prefer fish over other food types (Buehler 2000). Adults are known to scavenge prey items, pirate food from other species, and capture prey such as ducks from the water's surface.

Swallow-tailed kites breed in the southeastern United States but winter in South America, making long distance migrations each year between wintering and breeding grounds. Studies in Florida show swallow-tailed kites feed on various animals in the following proportions: frogs (53 percent), birds (30 percent), and reptiles (11 percent) and the remaining prey were insects (Meyer et al. 2004).

Most peregrine falcons occur throughout the nearshore and coastal portions of the Study Area, particularly near barrier islands and mudflats during the winter months. Some peregrine falcons migrate along the coast, cross bodies of water such as the Gulf of Mexico, and occur offshore of the Atlantic coast to reach their wintering/breeding territories on a yearly basis (Lott 2006). They can reach altitudes up to 12,000 ft. (3,660 m) (Cornell Lab of Ornithology 2011). Peregrine falcons feed mostly on other birds, including shorebirds, ducks, grebes, gulls, and petrels. They occasionally feed on fish while in coastal habitats (Cornell Lab of Ornithology 2011).

3.6.2.17 Shorebirds, Phalaropes, Gulls, Noddies, Terns, Skimmers, Skuas, Jaegers, and Alcids (Order Charadriiformes)

The Charadriiformes include shorebirds, phalaropes, gulls, noddies, terns, skimmers, skuas, jaegers, and alcids (Cornell Lab of Ornithology 2009a). There are 81 species from this diverse group that occur within the Study Area ranging from small shorebirds to large pelagic seabirds. Two endangered species under the ESA belong to this group, the roseate tern and piping plover (U.S. Fish and Wildlife Service 2010b). Nineteen species from this group are Birds of Conservation Concern (U.S. Fish and Wildlife Service 2008). Some species in this order are highly pelagic (e.g., jaegers, skuas, alcids), whereas others are more coastal or nearshore species (e.g., shorebirds, gulls).

Representative species from this group include: semipalmated plover (*Charadrius semipalmatus*), great skua (*Stercorarius skua*), long-tailed jaeger (*Stercorarius longicaudus*), sooty tern (*Onychoprion fuscatus*), brown noddy (*Anous stolidus*), dovekie (*Alle alle*), common murre (*Uria aalge*), razorbill (*Alca torda*), long-billed murrelet (*Brachyramphus perdix*), Atlantic puffin (*Fratercula arctica*), and red phalarope (*Phalaropus fulicarius*).

Noddies are tropical tern-like seabirds found foraging over warm, open-ocean waters where they feed by swooping or dipping along the surface. Brown noddies breed in colonies on islands, islets, and rocky outcrops in warm seas. They only lay one egg a year and build their nests in trees, shrubs, cliffs, and man-made structures (Sibley 2007).

Terns are generally more marine or pelagic than gulls, though some tern species do occur more commonly within coastal areas (e.g., least terns). In the North Atlantic, Gulf Stream eddies attract foraging seabirds such as the sooty tern and bridled tern (*Onychoprion anaethetus*) (Bost et al. 2009).

Alcids or auks (family Alcidae), are small oceanic species that come to land only to breed (Enticott and Tipling 1997); they nest colonially in crevices or burrows. Alcids do not undergo long-distance foraging trips but form feeding aggregations in areas where food is concentrated, though they do not form tight flocks (Enticott and Tipling 1997). All alcids use their wings to dive underwater where they feed on fishes and invertebrates. Auks are pursuit divers and are entirely wing-propelled rather than foot-propelled, as are loons, grebes, and long-tailed ducks, for example. Atlantic puffins can dive between 135 to 224 ft. (41 and 68 m) for periods of up to 1 minute (Burger and Simpson 1986).

Shorebirds are small, generally long-legged coastal birds that forage in intertidal areas by picking and probing for small aquatic prey (Sibley 2007). Shorebirds undergo some of the longest distance migrations known for birds, for example, the red knot annually migrates more than 9,300 mi. (15,000 km) (U.S. Fish and Wildlife Service 2005). Though most of their life cycle is spent in coastal areas, shorebird migration over open ocean does occur (Elphick 2007). Although taxonomically grouped among some shorebirds, two species of phalaropes in the family Scolopacidae that occur within the Study Area are functionally seabirds, spending the nonbreeding months out on the open ocean. For example, the red-necked phalarope (*Phalaropus lobatus*) spends up to 9 months at sea, gathering in small flocks at upwellings and convergence zones, foraging on zooplankton and other small aquatic animals that rise to the surface (Rubega et al. 2000). The red phalarope ranges farthest from shore, spending 11 months at sea feeding on small invertebrates (Tracy et al. 2002).

The Charadriiformes influence the distribution and abundance of invertebrates, and indirectly algae, in rocky intertidal communities of New England (Ellis et al. 2007). Gulls are one particular group that can be found over land, along the coast, in nearshore, and offshore environments. The great black-backed gull (*Larus marinus*) and the herring gull (*Larus argentatus*) are dominant predators along the rocky shores throughout the North Atlantic, feeding on crabs, sea urchins, and mussels in the rocky intertidal habitat.

3.6.2.18 Neotropical Migrant Songbirds, Thrushes, Allies, Cuckoos, Swifts, and Owls (Orders Passeriformes, Cuculiformes, and Apodiformes)

There are 185 bird species in the orders Passeriformes, Cuculiformes, Apodiformes, and Strigiformes that are considered nocturnal migrants and neotropical migrants with a potential to occur in the Study Area. Nineteen of these species are Birds of Conservation as shown in Table 3.6-3 (U.S. Fish and Wildlife Service 2008). Most of these species are nocturnal migrants and take advantage of favorable weather conditions to migrate (Kerlinger 2009). Oceans are typically an obstacle for this group of birds because most songbirds cannot swim, or even rest on the water’s surface. Migrants tend to avoid large water crossings and follow land to the extent possible. Migration has a substantial risk to birds, ranging from mass mortality events due to inclement weather events (Newton 2007) and other mortality events associated with lighting of vessels (Merkel and Johansen 2011) and oil and gas platforms (Poot et al. 2008). In the Gulf of Mexico, long distance migrants are commonly found stopping over and resting on oil and gas platforms as well as on small boats and vessels. However, most neotropical migrants, especially warblers and thrushes from the family Parulidae and family Turdidae, cross water at some point twice a year to reach their wintering and breeding grounds. For example, the Bicknell's thrush *(Cartharus bicknelli*) breeds in mountainous forests of New England and migrates across open oceans in the fall to reach their wintering grounds in the Caribbean.

3.6.3 ENVIRONMENTAL CONSEQUENCES

For this Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS), birds are evaluated as groups of species characterized by distribution, body type, or behavior relevant to the stressor being evaluated. Activities are evaluated for their potential effect on all birds in general, on each taxonomic grouping, and on the three birds in the Study Area listed as endangered or threatened under the ESA. As described in Section 3.6.2 (Affected Environment), birds are not distributed uniformly throughout the Study Area, but are closely associated with a variety of habitats, with coastal birds and shorebirds concentrated along nearshore habitats and seabirds with patchy (uneven) distributions in offshore and open ocean areas.

General characteristics of all Navy stressors were introduced in Section 3.0.5.3 (Identification of Stressors for Analysis), and general susceptibilities of living resources to stressors were introduced in Section 3.0.5.7 (Biological Resource Methods). Stressors vary in intensity, frequency, duration, and location within the Study Area. Certain activities take place in specific locations or depth zones within the Study Area (Section 3.0.5, Overall Approach to Analysis), outside of the range or foraging abilities of birds. Therefore, seafloor device strike, cable and wire entanglement, parachute entanglement, and ingestion of munitions were not carried forward in this analysis for birds. The stressors applicable to ESA-listed species in the Study Area and analyzed below include the following:

- Acoustic (sonar and other active acoustic sources; explosives and swimmer defense airguns; pile driving; weapons firing, launch, impact noise; and aircraft and vessel noise)
- Energy (electromagnetic devices and high energy lasers)
- Physical disturbance and strike (aircraft and aerial targets, vessels and in-water devices, and military expended materials)
- Ingestion (military expended materials)
- Secondary stressors

Each of these components is analyzed for potential impacts on birds within the stressor categories contained in this section. The specific analysis of the training and testing activities considers these components within the context of geographic location and overlap of marine bird resources. In addition to the analysis here, the details of all training and testing activities, stressors, components that cause the stressor, and geographic overlap within the Study Area are summarized in Section 3.0.5.3 (Identification of Stressors for Analysis) and detailed in Appendix A (Navy Activities Descriptions).

3.6.3.1 Acoustic Stressors

This section evaluates the potential for non-impulsive and impulsive acoustic stressors to impact birds during training and testing activities in the Study Area. These stressors are associated with sonar and other underwater active acoustic sources; explosive detonations; aircraft noise; vessel noise; airguns; weapons firing, launch, and impact noise; and pile driving. Following the Conceptual Framework for Assessing Effects from Sound-Producing Activities (Section 3.0.5.7.1), categories of potential impacts from exposure to explosions and sound are direct trauma, hearing loss, auditory masking, behavioral reactions, and physiological stress. Potential negative nonphysiological consequences to birds from acoustic and explosive stressors include disturbance of foraging, roosting, or breeding; degradation of foraging habitat; and degradation of breeding colonies.

If a bird is close to an explosive detonation, the exposure to high pressure levels and sound impulse can cause barotraumas. Barotrauma is physical injury due to a difference in pressure between an air space inside the body and the surrounding air or water. Damage could occur to the structure of the ear, resulting in hearing loss, or to internal organs, causing hemorrhage and rupture.

If a bird is close to an intense sound source, it could suffer auditory fatigue. Auditory fatigue manifests itself as hearing sensitivity loss over a portion of hearing range, called a noise-induced threshold shift. A threshold shift may be either permanent threshold shift (PTS) or temporary threshold shift (TTS). Studies have examined hearing loss and recovery in only a few species of birds, and none studied hearing loss in seabirds (e.g., Hashino et al. 1988; Ryals et al. 1999; Ryals et al. 1995; Saunders and Dooling 1974). A bird may experience permanent threshold shift if exposed to a continuous over 110 dBA re 20 µPa sound pressure level in air or blast noise over 140 dB re 20 µPa sound pressure level in air (Dooling and Therrien 2012). Unlike other species, birds have the ability to regenerate hair cells in the ear, usually resulting in considerable anatomical, physiological, and behavioral recovery within several weeks. Still, intense exposures are not always fully recoverable, even over periods up to a year after exposure, and damage and subsequent recovery vary significantly by species (Ryals et al. 1999). Birds may be able to protect themselves against damage from sustained sound exposures by regulating inner ear pressure, an ability that may protect ears while in flight (Ryals et al. 1999). Diving birds have adaptations to protect the middle ear and tympanum from pressure changes during diving that may affect hearing (Dooling and Therrien 2012). Auditory fatigue can impair an animal’s ability to hear biologically important sounds within the affected frequency range. Biologically important sounds come from social groups, potential mates, offspring, or parents; environmental sounds; or predators (see Section 3.0.5.7.1, Conceptual Framework for Assessing Effects from Sound-Producing Activities).

Numerous studies have documented that birds and other wild animals respond to human-made noise, including aircraft overflights, weapons firing, and explosions (Larkin et al. 1996; National Parks Service 1994; Plumpton et al. 2006). The manner in which birds respond to noise depends on several factors, including life history characteristics of the species; characteristics of the noise source, sound source intensity, onset rate, distance from the noise source, presence or absence of associated visual stimuli, and previous exposure (see Section 3.0.5.7.1, Conceptual Framework for Assessing Effects from Sound-Producing Activities).Researchers have documented a range of bird behavioral responses to noise, including no response, alert behavior, startle response, flying or swimming away, diving into the water, and increased vocalizations (Larkin et al. 1996; National Parks Service 1994; Plumpton et al. 2006; Pytte et al. 2003). Some behavioral responses may be accompanied by physiological responses, such as increased heart rate or short-term changes in stress hormone levels (Partecke J. et al. 2006).

Behavioral responses may depend on the characteristics of the noise, and if the noise is similar to biologically relevant sounds, such as alarm calls by other birds and predator sounds. For example, European starlings (*Sturnus vulgaris*) took significantly longer to habituate to repeated bird distress calls than white noise or pure tones (Johnson et al. 1985). Starlings may have been more likely to continue to respond to the distress because it is a more biologically meaningful sound. Starlings were also more likely to habituate in winter than summer, possibly meaning that food scarcity or seasonal physiological conditions may affect intensity of behavioral response (Johnson et al. 1985). Similarly, seismic surveys had no noticeable impacts on the movements or diving behavior of long-tailed ducks undergoing wing molt, a period in which flight is limited and food requirements are high (Lacroix et al. 2003). The birds may have tolerated the seismic survey noise to stay in preferred feeding areas. The sensitivity of birds to disturbance may also vary during different stages of the nesting cycle. Similar noise levels may be more likely to cause nest abandonment during incubation of eggs than during brooding of chicks because birds have invested less time and energy and have a greater chance of re-nesting (Knight and Temple 1986).

Chronic stress due to disturbance may compromise the general health and reproductive success of birds (Kight et al. 2012), but a physiological stress response is not necessarily indicative of negative consequences to individual birds or to populations (Bowles et. al. in Larkin et al. 1996; National Parks Service 1994). The reported behavioral and physiological responses of birds to noise exposure can fall within the range of normal adaptive responses to external stimuli, such as predation, that birds face on a regular basis. These responses can include activation of the neural and endocrine systems, causing changes such as increased blood pressure, available glucose, and blood levels of corticosteroids (Manci et al. 1988). It is possible that individuals would return to normal almost immediately after exposure, and the individual's metabolism and energy budget would not be affected long-term. Studies have also shown that birds can habituate to noise following frequent exposure and cease to respond behaviorally to the noise (Larkin et al. 1996; National Parks Service 1994; Plumpton et al. 2006). However, the likelihood of habituation is dependent upon a number of factors, including species of bird (Bowles et al. 1991), and frequency of and proximity to exposure. Raptors have been shown to shift their terrestrial home range when concentrated military training activity was introduced to the area (Andersen et al. 1990). On the other hand, cardinals nesting in areas with high levels of military training activity (including gunfire, artillery, and explosives) were observed to have similar reproductive success and stress hormone levels as cardinals in areas of low activity (Barron et al. 2012).

The types of birds exposed to sound-producing activities or explosive detonations depend on where training and testing activities occur relative to the coast. Seabirds can be divided into three groups based on breeding and foraging habitat: (1) those species such as albatrosses, petrels, frigatebirds, tropicbirds, boobies, and some terns that forage over the ocean and nest on oceanic islands; (2) species such as pelicans, cormorants, gulls, and some terns that nest along the coast and forage in nearshore areas; and (3) those few species such as skuas, jaegers, Franklin’s gull, Bonaparte’s gulls, ring-billed gulls, and black terns that nest and forage in inland habitats and come to the coastal areas during nonbreeding seasons (Schreiber and Burger 2002). In addition, birds that are typically found inland, such as songbirds, may be present flying in large numbers over open ocean areas (particularly over the Gulf of Mexico) during annual spring and fall migration periods.

The area from the beach to about 10 nautical miles (nm) offshore provides foraging areas for breeding terns, gulls, skimmers, and pelicans; a migration corridor and winter habitat for terns, gulls, skimmers, pelicans, loons, cormorants, and gannets; and supports nonbreeding and transient pelagic seabirds. Offshore pelagic waters support nonbreeding and transient pelagic seabirds, loons, gannets, and several tern species (Davis et al. 2000; Hunter et al. 2006b). Pelagic seabirds are generally widely distributed, but they tend to congregate in areas of higher productivity and prey availability (Haney 1986a). Such areas include the Gulf Stream, particularly the western frontal boundary and associated eddies and upwelling; areas with productive live/hard bottom habitats; and large *Sargassum* mats.

Seabirds and migrating birds could be exposed to sounds from sources near the water surface or from airborne sources. While foraging birds will be present near the water surface, migrating birds may fly at various altitudes. Some species such as sea ducks and loons may be commonly seen flying just above the water's surface, but the same species can also be spotted flying so high that they are barely visible through binoculars (Lincoln et al. 1998). While there is considerable variation, the favored altitude for most small birds appears to be between 500 ft. (152 m) and 1,000 ft. (305 m). Radar studies have demonstrated that 95 percent of the migratory movements occur at less than 10,000 ft. (3,050 m), with the bulk of the movements occurring under 3,000 ft. (914 m) (Lincoln et al. 1998).

Seabirds use a variety of foraging behaviors that could expose them to underwater sound. Most seabirds plunge-dive from the air into the water or perform aerial dipping (the act of taking food from the water surface in flight); others surface-dip (swimming and then dipping to pick up items below the surface) or jump-plunge (swimming, then jumping upward and diving under water). Birds that feed at the surface by surface or aerial dipping with limited to no underwater exposure include petrels, jaegers, and phalaropes. Birds that plunge-dive typically submerge for no more than a few seconds, and any exposure to underwater sound would be very brief. Birds that plunge-dive include albatrosses, some tern species, masked boobies, shearwaters, and tropicbirds. Other birds pursue prey under the surface, swimming deeper and staying underwater longer than other plunge-divers. Birds that exhibit this foraging behavior include cormorants, razorbills, petrels, shearwaters, and common murres. Some of these birds may stay underwater for up to several minutes and reach depths between 50 ft. (15 m) and 550 ft. (168 m) (Alderfer 2003; Durant et al. 2003; Jones 2001; Lin 2002; Ronconi 2001). Birds that forage near the surface would be exposed to underwater sound for shorter periods of time, and some exposures may be reduced by phase cancellation near the surface (see Section 3.0.4, Acoustic and Explosives Primer). Sounds generated under water during training and testing would be more likely to impact birds that pursue prey under the surface, although as previously stated, little is known about seabird hearing ability underwater. Birds that forage in the open ocean often forage more actively at night, when prey species are more likely to be near the surface and naval training and testing is more limited.

3.6.3.1.1 Impacts from Sonar and Other Active Acoustic Sources

Sonar and other underwater active non-impulsive acoustic sources could be used throughout the Study Area. Information regarding the impacts from sonar on seabirds and the ability for seabirds to hear underwater is virtually unknown. The exposure to these sounds by seabirds, other than pursuit diving species, is likely to be very limited due to spending a very short time under water (plunge-diving or surface-dipping) or foraging only at the water surface. In addition, acoustic effects near the water's surface may reduce potential sound exposure of shallow diving birds. Pursuit divers may remain under water for minutes, increasing the chance of underwater sound exposure.

A physiological impact, such as hearing loss, would likely only occur if a bird is close to an intense sound source. In general, birds are less susceptible to both temporary and permanent threshold shift than mammals (Saunders and Dooling 1974), so an underwater sound exposure would have to be intense and of a sufficient duration to cause temporary or permanent threshold shift. Avoiding the sound by returning to the surface would limit extended or multiple sound exposures underwater; however, foraging and hunting behaviors could be interrupted. There have been no studies documenting diving seabirds' reactions to sonar.

If seabirds that forage underwater are attracted to the presence of a ship using active acoustic sources, the diving seabirds could be exposed to underwater sound. Some birds commonly follow vessels for increased potential of foraging success as the propeller wake brings prey to the surface (Dietrich and Melvin 2004; Hamilton III 1958; Hyrenbach 2001, 2006; Melvin et al. 2001). However, most hull-mounted sonars do not project sound aft of ships, so birds diving in ship wakes would not be exposed to sonar. In addition, based on what is known about bird hearing capabilities in air, it is expected that diving birds may have limited or no ability to perceive high-frequency sounds, so it is expected that they would not be impacted by high frequency sources such as those used in mine warfare.

The possibility of an ESA-listed bird species being exposed to sonar and other active acoustic sources depends on whether it submerges during foraging and whether it forages in areas where these sound sources may be used. Although Bermuda petrels forage in open ocean areas where sonar training and testing occurs, they would not be exposed to underwater sound because they forage at the surface. Roseate terns forage in coastal shallow waters where they could be exposed to sonar and other active acoustic sources, notably near ports and shipyards where sonar maintenance and testing occur. However, their plunge dives are brief, so any chance of exposure would be minimal. Most other sonar use occurs farther offshore, however, so the chance for an exposure would be low. Piping plovers forage in intertidal areas where they would not be exposed to underwater sound sources.

3.6.3.1.1.1 No Action Alternative

Training Activities

Training activities under the No Action Alternative include activities that produce non-impulsive underwater sound from the use of sonar and other active acoustic sources. These activities could occur throughout the Study Area but would be concentrated Southeast in the U.S. Continental Shelf Large Marine Ecosystem and the Gulf Stream Open Ocean Area. Most activities would occur in the VACAPES, Navy Cherry Point, and Jacksonville (JAX) Range Complexes. The number of events and their proposed locations are presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Use of sonar and other active acoustic sources during training activities is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

Diving birds would be more likely to be exposed to underwater sound in foraging areas. The western front of the Gulf Stream is an area of increased productivity that attracts foraging seabirds, and training would occur in this area. Therefore, seabirds that forage in this area could have a greater chance of underwater sound exposure. Sonar and other active acoustic sources would not be regularly used in nearshore areas that could be used by foraging shorebirds, except during maintenance and for navigation in areas around ports.

Exposures sufficiently intense (i.e., of a certain duration or within a close proximity) to cause physiological impacts are unlikely. Diving birds may not respond to an underwater sound or may not have the hearing range to detect some sources. If a diving seabird does react to an underwater sound source, it is expected to result in a short-term behavioral response, such as a startle or surfacing. Seabirds would avoid any additional exposures during a foraging dive when they surface. It is likely that few seabirds would be affected by sonar and other underwater active acoustic sources because sources are used intermittently during a training event, training events are dispersed in space and time, and seabirds spend only a portion of their time submerged. Due to the limited duration of training events and widespread availability of foraging habitat, any sound exposures would be minimal and would not permanently displace an animal from a foraging area. Occasional short-term, behavioral impacts, if they occur, are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness) to most individuals, therefore, population-level impacts are not expected.

Bermuda petrels, red knots, and piping plovers do not submerge while foraging; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Roseate terns may briefly submerge while foraging, so there is a remote chance that a roseate tern could be exposed to underwater sound sonar and other active acoustic sources.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed roseate tern;*
- *will have no effect on the ESA-listed Bermuda petrel and piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from sonar and other active acoustic sources during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

The number of annual testing activities that produce in-water noise from the use of sonar and other active acoustic sources that fall within the hearing range of birds under the No Action Alternative. These activities could occur throughout the Study Area, typically in the Northeast U.S Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, and the Gulf Stream Open Ocean Area. These activities would typically occur in the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes; Naval Surface Warfare Center, Panama City Division Testing Range; Naval Undersea Warfare Center Division, Newport Testing Range; and pierside at Navy ports, Navy shipyards, and Navy-contractor shipyards. Use of sonar and other active acoustic sources during training activities is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

Ocean fronts, including the western front of the Gulf Stream, Gulf Stream eddies, and the front at the intersection of the continental shelf and slope, are areas of increased productivity that could attract seabirds that forage in open ocean areas. Seabirds that forage in these open ocean areas would have a greater chance of underwater sound exposure than birds that forage in coastal areas. Sonar and other active acoustic sources would not be regularly used in nearshore areas that could be used by foraging shorebirds, except during maintenance, navigation, and new ship construction activities in areas around ports.

Exposures sufficiently intense (i.e., of a certain duration or within a close proximity) to cause physiological impacts are unlikely. Diving birds may not respond to an underwater sound or may not have the hearing range to detect some sources. If a diving seabird does react to an underwater sound source, it is expected to result in a short-term behavioral response, such as a startling or surfacing. Seabirds would avoid any additional exposures during a foraging dive when they surface. It is likely that few seabirds would be affected by sonar and other underwater active acoustic sources because sources are used intermittently during a testing event, testing events are dispersed in space and time, and seabirds spend only a portion of their time submerged. Due to the limited duration of testing events and widespread availability of foraging habitat, any sound exposures would be minimal and would not permanently displace an animal from a foraging area. Occasional short-term, behavioral impacts, if they occur, are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness) to most individuals, therefore, population-level impacts are not expected.

Bermuda petrels, red knots, and piping plovers do not submerge while foraging; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Roseate terns may briefly submerge while foraging, so there is a remote chance that a roseate tern could be exposed to underwater sound from sonar and other active acoustic sources.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed roseate tern;*
- *will have no effect on the ESA-listed Bermuda petrel and piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from sonar and other active acoustic sources during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.1.2 Alternative 1

Training Activities

The number of annual training activities that produce in-water noise from the use of sonar and other active acoustic sources during training under Alternative 1 would increase compared to the No Action Alternative, plus new sources would be used with the introduction of the Littoral Combat Ship. Similar to the No Action Alternative, impacts could occur throughout the Study Area but would be concentrated in the Southeast U.S. Continental Shelf Large Marine Ecosystem and in the Gulf Stream Open Ocean Area. These activities would typically occur in the VACAPES, Navy Cherry Point, and JAX Range Complexes. Use of sonar and other active acoustic sources during training activities is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

Based on the increased activities under Alternative 1 versus the No Action Alternative, more seabirds could be exposed to sonar and other active acoustic sources. Although the quantity of underwater acoustic stressors would increase, any impacts on seabirds would likely be limited to short-term behavioral reactions by diving seabirds as described under the No Action Alternative. Due to the reasons described in Section 3.6.3.1.1.1 (No Action Alternative), any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population.

Bermuda petrels, red knots, and piping plovers do not submerge while foraging; therefore, they would not be exposed to underwater sound from sonar and other active acoustic sources. Roseate terns may briefly submerge while foraging, so there is a remote chance that a roseate tern could be exposed to underwater sound sonar and other active acoustic sources.

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed roseate tern;*
- *will have no effect on the ESA-listed Bermuda petrel and piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from sonar and other active acoustic sources during training activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Testing activities under Alternative 1 that produce in-water noise from the use of sonar and other active non-impulsive acoustic sources that fall within the hearing range of birds would increase compared to the No Action Alternative. These activities could occur throughout the Study Area, typically in the Northeast U.S Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems, and the Gulf Stream Open Ocean Area. These activities would typically occur in the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes; Naval Surface Warfare Center, Panama City Division Testing Range; Naval Undersea Warfare Center Division, Newport Testing Range; the South Florida Ocean Measurement Facility Testing Range; and pierside at Navy ports, Navy shipyards, and Navy-contractor shipyards. The number of events and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of sonar and other active acoustic sources is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

Based on the increased activities under Alternative 1 versus the No Action Alternative and the additional testing locations, more diving seabirds could be exposed to sonar and other active acoustic sources. Although the quantity of underwater acoustic stressors would increase, any impacts on seabirds would likely be limited to short-term behavioral reactions by diving seabirds, as described under the No Action Alternative. Due to the reasons described in Section 3.6.3.1.1.1 (No Action Alternative), any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population. Similarly, no impacts are expected to Bermuda petrels, red knots, and piping plovers, but there is a remote chance that roseate terns may be exposed while briefly submerging during foraging.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed roseate tern;*
- *will have no effect on the ESA-listed Bermuda petrel and piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from sonar and other active acoustic sources during testing activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.1.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be identical as described in Section 3.6.3.1.1.2 (Alternative 1).

Pursuant to the ESA, the use of sonar and other active acoustic sources during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed roseate tern;*
- *will have no effect on the ESA-listed Bermuda petrel and piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from sonar and other active acoustic sources during training activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources) describes the use of sonar and other underwater active acoustic sources during testing activities under Alternative 2, including relative concentrations and locations within the Study Area. Use of sonar and other active acoustic sources would increase under Alternative 2 versus the No Action Alternative. The proposed testing activities would also increase over Alternative 1 by approximately 10 percent. Sonar and other active acoustic sources would be used in waters throughout the range complexes and testing ranges, in the same locations described under Alternative 1. Although the quantity of underwater acoustic stressors would increase, any impacts on seabirds would likely be limited to short-term behavioral reactions by diving seabirds, as described under the No Action Alternative. Due to the reasons described in Section 3.6.3.1.1.1 (No Action Alternative), any sound exposures would be minimal and are unlikely to have a long-term impact on an individual or a population. Similarly, no impacts are expected to Bermuda petrels, red knots, and piping plovers, but there is a remote chance that roseate terns may be exposed while briefly submerging during foraging.

Pursuant to the ESA, the use of sonar and other active acoustic sources during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed roseate tern;*
- *will have no effect on the ESA-listed Bermuda petrel and piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from sonar and other active acoustic sources during testing activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.2 Impacts from Explosives and Swimmer Defense Airguns

The potential for birds to be exposed to explosions depends on several factors, including the presence of birds at, beneath, or above the water surface near the detonation; location of the detonation at, below, or above the water surface; size of the explosive; and distance from the detonation. Explosions are associated with detonations of explosive missiles and projectiles in air; explosive grenades, bombs, missiles, rockets, and projectiles at or near the sea surface; mine neutralization charges on the bottom and in the water column; explosive torpedoes near the surface and in the water column; explosive sonobuoys in the water column; other small charges used at various depths during testing; and ship shock trial detonations 200 ft. (61 m) below the water surface. Section 3.0.4 (Acoustic and Explosives Primer), describes the shock waves and acoustic waves imparted to a surrounding medium by an explosive detonation and how these waves propagate. Because airguns are an impulsive source, with the potential for similar non-traumatic impacts as explosives, they are considered in this section.

Detonations near the water surface or underwater could impact diving birds and birds on the water surface. A seabird close to an explosive detonation could be killed or injured. Blast injuries are usually most evident in the gas-containing organs, such as those of the respiratory and gastrointestinal systems. Blasts can also damage pressure-sensitive components of the auditory system. Most detonations of explosive projectiles near the water surface would release a large portion of the explosive energy into the air rather than into the water column.

Detonations that occur underwater, such as explosive ordnance disposal activities, could injure, kill, or disturb diving birds, particularly pursuit divers that spend more time underwater than other foraging birds (Danil and St. Ledger 2011). Studies show that birds are more susceptible to underwater explosions when they are submerged versus on the surface (Yelverton et al. 1973). Detonations are estimated to have lethal impacts on seabirds in water if the impulse exceeds 36 pounds per square inch (psi)–milliseconds (ms) (psi-ms) (248 pascal [Pa]-second [s]) for birds underwater and 100 psi-ms (690 Pa-s) just below the water surface for birds at the water surface (Yelverton et al. 1973). These impulse levels correspond to the level at which 1 percent of animals would not be expected to survive. Exposures to higher impulse levels would have greater likelihoods of mortality. No injuries would be expected for birds underwater at blast pressures below 6 psi-ms (41 Pa-s) and for birds on the surface at blast pressures below 30 psi-ms (207 Pa-s) (Yelverton et al. 1973). Actual ranges to impacts would be based on several factors including charge size, depth of the detonation, and how far the bird is beneath the water surface. Due to surface image interference (Section 3.0.4, Acoustic and Explosive Primer), peak pressures due to underwater explosions may be substantially reduced near the surface, reducing potential for injury to birds on the surface and shallow-diving birds.

Because of the differences in acoustic transmission in water and in air, an effect called the Lloyd mirror reflects underwater sound at the water surface so that it does not pass into the air (Section 3.0.4, Acoustic and Explosives Primer). Sounds generated by most small underwater explosions and airguns, therefore, are unlikely to disturb seabirds above the water surface. If a detonation is sufficiently large or is near the water surface, however, pressure will be released at the air-water interface. Birds above this pressure release could be injured or killed. Cavitation zones near the surface can also disturb or injure birds at or near the surface (see Section 3.0.4, Acoustic and Explosives Primer).

Explosives detonated at or just above the water surface, such as those used in anti-surface warfare, would create blast waves and acoustic waves that would propagate through both the water and air. However, most pressure release would be into the air and underwater impacts would be reduced.

Detonations in air could also injure birds while either in flight or at the water surface. Experiments that exposed birds to blast waves in air provided a relationship between charge size, distance from detonation, and likelihood of bird injury or mortality (Damon et al. 1974). Table 3.6-4 shows the safe distance from a detonation in air beyond which no injuries to birds would be expected.

Table 3.6-4: Range to No Injury from Detonations in Air for Birds

Explosive Source Class	Sample Munitions	Net Explosive Weight	Range to No Injury[1]
E3	76-mm round	0.6–2 lb.	22 ft. (7 m)
E5	5-in. projectiles	6–10 lb.	22 ft. (10 m)
E7	Rolling Airframe Anti-Air Missile	21–60 lb.	70 ft. (21 m)

ft.: feet; in.: inch; lb.: pound(s); m: meters; mm: millimeter
[1] (Damon et al. 1974)

Detonations in air during anti-air warfare training and testing would typically occur at much higher altitudes (greater than 3,000 ft. [914 m] above sea level) where seabirds and migrating birds are less likely to be present, although some events target incoming missile threats at lower altitudes.

Detonations in either the air or under water are assumed to have the potential to cause a permanent or temporary threshold shift, if a bird is exposed to sufficient energy to cause auditory fatigue. As stated previously, studies have examined hearing loss and recovery in only a few species of birds, and none studied hearing loss in seabirds (e.g., Hashino et al. 1988; Ryals et al. 1999; Ryals et al. 1995; Saunders and Dooling 1974). Unlike other species, birds have the ability to regenerate hair cells in the ear, usually resulting in considerable anatomical, physiological, and behavioral recovery within several weeks. Still, intense exposures are not always fully recoverable, even over periods up to a year after exposure, and damage and subsequent recovery vary significantly by species (Ryals et al. 1999). Birds may be able to protect themselves against damage from sustained sound exposures by regulating inner ear pressure, an ability that may protect ears while in flight (Ryals et al. 1999). Auditory fatigue can impair an animal's ability to hear biologically important sounds within the affected frequency range.

An explosive detonation would likely cause a startle reaction, as the exposure would be brief and any reactions are expected to be short-term. Startle impacts range from altering behavior (e.g., stop feeding or preening), minor behavioral changes (e.g., head turning), or a flight response. The range of impacts could depend on the charge size, distance from the charge, and the bird's life activity at the time of the exposure.

Birds have been observed taking interest in surface objects related to detonation events and subsequently being killed by a detonation (Stemp, R., in Greene et al. 1985). Fleeing response to an initial explosion may reduce seabird exposure to any additional explosions that occur within a short timeframe. However, seabirds could also be attracted to an area to forage if an explosion resulted in a fish kill. This would only be a concern for events that involved multiple explosions in the same area within a single event, such as firing exercises, which involves firing multiple high-explosive 5-in. rounds at a target area; bombing exercises, which could involve multiple bomb drops separated by several minutes; or underwater detonations, such as multiple explosive ordnance disposal charges.

3.6.3.1.2.1 No Action Alternative

Training Activities

Training activities under the No Action Alternative use explosives in air, at the water surface, and underwater. The largest source class used during training under the No Action Alternative would be E12 (651-1,000 pounds [lb.] net explosive weight) at the water surface. The number of training events using explosives and their proposed locations are presented in Table 2.8-1 of Chapter 2 (Description of

Proposed Action and Alternatives). Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Most detonations associated with training would occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem, Southeast U.S. Continental Shelf Large Marine Ecosystem, and Gulf Stream Open Ocean Area. Explosions at or beneath the water surface would be used in all training range complexes, except Key West Range Complex. Training activities using explosives would not typically occur within approximately 3 nm of shore. In-air explosions during anti-air warfare would typically take place in VACAPES, Navy Cherry Point, and JAX Range Complexes.

Nearshore waters are the primary foraging habitat for many seabird species. With the exception of explosive ordnance disposal training (underwater detonations up to 20 lb. net explosive weight) in the VACAPES, Navy Cherry Point and JAX Range Complexes, birds near shore would not be exposed to explosive detonations associated with the training activities. A limited number of these events occur nearshore (approximately three nm), where they could briefly disturb shorebirds in the vicinity. Some surface detonations could occur near areas with the potential for relatively high concentrations of seabirds near the western frontal boundary of the Gulf Stream (see Figures 3.0-2 and 3.0-3), including firing, bombing, and missile exercises in either VACAPES or Navy Cherry Point Range Complexes. Any impacts on seabirds may be greater in these areas. Most explosions in air would occur at altitudes above those where most birds would be expected to be present, although it is possible that high-altitude migrating birds could be exposed to a detonation. In addition, some airborne detonations targeting threat missiles could impact foraging birds at lower altitudes.

While the impacts of explosions on seabirds under the No Action Alternative cannot be quantified due to limited data on seabird density, lethal injury to some seabirds could occur. Detonations of bombs with larger net explosive weights, any event employing static targets that may attract seabirds to the detonation site, or multiple detonations that attract seabirds to possible fish kills could be more likely to cause sea bird moralities or injuries. Any impacts related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent. Because most events would consist of a limited number of detonations, exposures would not occur over long durations, and events occur at varying locations, it is expected there would be an opportunity to recover from an incurred energetic cost and individual birds would not be repeatedly exposed to explosive detonations. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected.

ESA-listed birds are known to be present in areas where detonations would occur during training under the No Action Alternative. Bermuda petrels and roseate terns may be present near the Gulf Stream, where detonations could occur, although little is known about Bermuda petrel distribution. Although Bermuda petrel and roseate tern could be present in range complexes where explosives are used, the likelihood of an injurious exposure is expected to be low based on the limited in-air range of injury from explosions and the expected low density of these birds. Piping plovers may be briefly disturbed in the vicinity of nearshore activities; however, they would not forage or migrate in the open ocean areas where other detonations occur.. Red knots could be present during migration over open ocean areas where detonations could occur. If a detonation occurred in the vicinity of migrating red knots, impacts would likely be limited to short-term startle reactions.

Suitability of critical habitat designated in coastal shore areas for piping plover to support roosting, refuge, and feeding would not be affected by explosions offshore or by in-air detonations. Designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems; however, none of these areas overlap with the use of explosives in the Study Area. Two of the primary constituent elements of critical habitat required by piping plover (i.e., sheltering and roosting) are applicable to their terrestrial beach habitats (above the high tide line), which are outside of the Study Area. The other primary constituent element is foraging. While piping plovers do forage in the intertidal portions of the Study Area, these areas do not overlap with any locations where explosives are used. Therefore, explosives will not affect piping plover critical habitat.

Pursuant to the ESA, the use of explosives during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed roseate tern, Bermuda petrel, and piping plover;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from explosives during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Testing activities under the No Action Alternative use explosives at the water surface and underwater. The largest source class used during testing under the No Action Alternative is E14 (1,741-3,625 lb. net explosive weight). The number of testing activities using explosives and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Explosives at or beneath the water surface would be used in all training range complexes, plus Naval Undersea Warfare Center, Panama City Division Testing Range. Most detonations associated with testing would occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, and Gulf Stream Open Ocean Area. Testing activities using explosives do not normally occur within 3 nm of shore; the exception would be the designated underwater detonation area near Naval Surface Warfare Center, Panama City Division Testing Range, which is located nearshore, partially within the surf zone. In addition, small airguns would be used during pierside integrated swimmer defense testing activities at pierside locations at Joint Expeditionary Base Little Creek, Norfolk, Virginia, and at Newport, Rhode Island, as described in Table 2.8-3 and Section 3.0.5.3.1.4 (Swimmer Defense Airguns), and are included here because they produce underwater impulsive sound. In-air explosions are not analyzed for testing under the No Action Alternative.

Nearshore waters are the primary foraging habitat for many seabird species. With the exception of line charge detonations near the surf zone in the Naval Surface Warfare Center, Panama City Division Testing Range, birds near shore would not be exposed to explosive detonations associated with the testing activities. The limited number of these line charge events that occur could briefly disturb shorebirds in the vicinity. Some surface detonations could occur near areas with the potential for relatively higher concentrations of seabirds near the western frontal boundary of the Gulf Stream (see Figures 3.0-2 and 3.0-3). Any impacts on seabirds may be greater in these areas.

While the impacts of explosions on seabirds under the No Action Alternative cannot be quantified due to limited data on seabird density, lethal injury to some seabirds could occur. Detonations of bombs with larger net explosive weights, any event employing static targets that may attract seabirds to the detonation site, or multiple detonations that attract seabirds to possible fish kills could be more likely to cause sea bird moralities or injuries. Airgun detonations may startle diving birds foraging in port areas where underwater airgun detonations would occur. Any impacts related to startle reactions, displacement from a preferred area, or reduced foraging success would likely be short-term and infrequent. Because most events would consist of a limited number of detonations, exposures would not occur over long durations, and events occur at varying locations, it is expected there would be an opportunity to recover from an incurred energetic cost and individual birds would not be repeatedly exposed to explosive detonations. Although a few individuals may experience long-term impacts and potential mortality, population-level impacts are not expected.

ESA-listed birds are known to be present in areas where detonations would occur during testing under the No Action Alternative. Bermuda petrels and red knots could be present in the VACAPES Range Complex, where air-to-surface missiles are detonated, although little is known about Bermuda petrel distribution. Migrating roseate terns could also be present over open ocean areas where detonations could occur, and may also forage in nearshore waters such as those near Newport, Rhode Island where airgun detonations would occur. Although Bermuda petrel and roseate tern could be present in range complexes where explosives are used, the likelihood of an injurious exposure is expected to be low based on the limited in-air range of injury from explosions and the expected low density of these birds. In addition, because of the limited number of airgun events and the short duration of roseate tern dives, use of airguns is not expected to impact roseate terns. Piping plovers and red knots may be briefly disturbed in the vicinity of nearshore testing at Naval Surface Warfare Center, Panama City Division Testing Range; however, they would not forage or migrate in the open ocean areas where other detonations occur.

Suitability of critical habitat designated in coastal shore areas for piping plover to support roosting, refuge, and feeding would not be affected by explosions offshore or by in-air detonations. Designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems; however, none of these areas overlap with the use of explosives in the Study Area. Two of the primary constituent elements of critical habitat required by piping plover (i.e., sheltering and roosting) are applicable to their terrestrial beach habitats (above the high tide line), which are outside of the Study Area. The other primary constituent element is foraging. While piping plovers do forage in the intertidal portions of the Study Area, these areas do not overlap with any locations where explosives are used. Therefore, explosives will not affect piping plover critical habitat.

Pursuant to the ESA, the use of explosives and swimmer defense airguns during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed roseate tern, Bermuda petrel, and piping plover;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from explosives during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.2.2 Alternative 1

Training Activities

The number of explosive detonations under Alternative 1 would increase over the No Action Alternative. Training would generally occur in the same areas as under the No Action Alternative. The largest source class used during training under Alternative 1 would be E12 (651-1,000 lb. net explosive weight). The number of training events using explosives and their proposed locations are presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives).

Most detonations associated with training would occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, and in the Gulf Stream Open Ocean Area. Explosives at or beneath the water surface would be used in all training range complexes, including activities at the Key West Range Complex. Training activities using explosives would not typically occur within approximately 3 nm of shore. In-air explosions during anti-air warfare activities could take place in all training range complexes.

Although the impacts to birds are expected to increase under Alternative 1 compared to the No Action Alternative due to an increase in training events, the largest source class of net explosive weight would not increase and the expected impacts on any individual bird would remain the same. For the same reasons provided in Section 3.6.3.1.2.1 (No Action Alternative), long-term impacts and potential mortality to a few individuals, and other short-term startle reactions to dispersed training events, are not expected to result in population-level impacts. Potential impacts on ESA-listed or candidate species and critical habitat are expected to be similar to the No Action Alternative.

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed piping plover, Bermuda petrel, and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from explosives during training activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

The number of testing activities that use explosions under Alternative 1 would increase over the No Action Alternative. The number of events and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of sonar and other active acoustic sources is discussed in Section 3.0.5.3.1.1 (Sonar and Other Active Acoustic Sources).

The largest source class used during these annually recurring testing events would be E14 (1,741 – 3,625 lb. net explosive weight). Explosives at or beneath the water surface would be used during annually recurring testing in all training range complexes, plus Naval Surface Warfare Center, Panama City Division Testing Range. Testing activities using explosives would not normally occur within 3 nm of shore, except at Naval Surface Warfare Center, Panama City Division Testing Range. The most substantial increase in explosives use would occur during the ship shock trials of three platforms in the VACAPES or JAX Range Complexes - aircraft carrier (one event in five years), destroyer (one event in five years), and Littoral Combat Ship (two events in five years). Aircraft carrier full ship shock trials could use charges up to source class E17 (14,501 – 58,000 lb. net explosive weight). Destroyer and Littoral Combat Ship full ship shock trials could use charges up to source class E16 (7,251 – 14,500 lb. net explosive weight). In-air explosions could occur in the VACAPES, Navy Cherry Point, JAX, and Key West Range Complexes. The number of testing activities using explosives and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives). In addition, small airguns would create underwater impulsive noise during a small number of pierside integrated swimmer defense testing activities at pierside locations at Joint Expeditionary Base Little Creek, Norfolk, Virginia, and at Newport, Rhode Island, and during Stationary Source Testing at Naval Surface Warfare Center, Panama City Division Testing Range, as described in Table 2.8-3 and Section 3.0.5.3.1.4 (Swimmer Defense Airguns), and are included here because they produce underwater impulsive sound.

Nearshore waters are the primary foraging habitat for many seabird species. Birds near shore at Naval Surface Warfare Center, Panama City Division Testing Range could be exposed to noise from explosive detonations associated with the testing activities. Some surface detonations could occur near areas with the potential for relatively higher concentrations of seabirds near the western frontal boundary of the Gulf Stream (see Figures 3.0-2 and 3.0-3). Any impacts on seabirds may be greater in these areas. Most explosions in air would occur at altitudes above those where most birds would be expected to be present, although it is possible that high-altitude migrating birds could be exposed to a detonation. In addition, some airborne detonations targeting threat missiles could impact foraging birds at lower altitudes.

Due to the large charge sizes detonated during ship shock trials, these activities are given extra consideration. Highly productive areas such as water mass boundaries were avoided during the site selection process, reducing the likelihood of the presence of foraging seabirds (U.S. Department of the Navy 2008). No endangered or threatened bird species are expected to be present at or near the Jacksonville location, off the east coast of Florida, however, Bermuda petrels and roseate terns may occur offshore of Norfolk, Virginia. Seabirds resting or feeding at the surface or diving could also be killed or injured by the underwater shock wave. Any seabirds on the water surface or in the air immediately above the ship shock charge detonation point could be killed or stunned by cavitation or by the plume of water ejected into the air (refer to Section 3.0.5.3.1, Acoustic Stressors, for a description of large underwater detonations). This could happen if surface floats or ships attract birds to the detonation point.

Although the impacts to birds are expected to increase under Alternative 1 compared to the No Action Alternative, the expected impacts on any individual bird would remain the same. For the same reasons provided in Section 3.6.3.1.2.1 (No Action Alternative), long-term impacts and potential mortality to a few individuals, and other short-term startle reactions to dispersed testing events, are not expected to result in population-level impacts.

The increase in activities would increase the potential to expose ESA-listed birds to effects from explosions. Bermuda petrels and roseate terns could be present in range complexes where explosives are used, including near the ship shock trial site offshore of Norfolk, Virginia. Although injurious exposures could occur, the likelihood is expected to be low based on the limited in-air range of injury from most explosions and the expected low density of these birds. In addition, because of the limited number of airgun events and the short duration of roseate tern and red knot dives, use of airguns is not expected to impact nearshore roseate terns. Piping plovers may be briefly disturbed in the vicinity of nearshore testing at Naval Surface Warfare Center, Panama City Division Testing Range; however, they would not forage or migrate in the open ocean areas where other detonations occur.

Suitability of critical habitat designated in coastal shore areas for piping plover to support roosting, refuge, and feeding would not be affected by explosions offshore or by in-air detonations. Designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems; however, none of these areas overlap with the use of explosives in the Study Area. Two of the primary constituent elements of critical habitat required by piping plover (i.e., sheltering and roosting) are applicable to their terrestrial beach habitats (above the high tide line), which are outside of the Study Area. The other primary constituent element is foraging. While piping plovers do forage in the intertidal portions of the Study Area, these areas do not overlap with any locations where explosives are used. Therefore, explosives will not affect piping plover critical habitat.

Pursuant to the ESA, the use of explosives and swimmer defense airguns during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed piping plover, Bermuda petrel, and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from explosives and other impulsive sources during testing activities described under Alternative 1would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.2.3 Alternative 2 (Preferred Alternative)

<u>Training Activities</u>

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be identical as described in Section 3.6.3.1.2.2 (Alternative 1).

Pursuant to the ESA, the use of explosives during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed piping plover, Bermuda petrel, and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from explosives during training activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

The number of annually recurring testing activities that use explosions under Alternative 2 would increase compared to the No Action Alternative. The most substantial increase in explosives use would occur during the ship shock trials of three platforms in the VACAPES or JAX Range Complexes - aircraft carrier (one event in five years), destroyer (one event in five years), and Littoral Combat Ship (two events in five years). Compared to Alternative 1, the number of detonations during annually recurring testing activities would increase by approximately 10 percent. Types of testing activities (both annually recurring activities and ship shock trials), source classes, and locations would be the same as those under Alternative 1. The number of testing activities using explosives and their proposed locations are presented in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). Use of explosives and the number of detonations in each source class are provided in Section 3.0.5.3.1.2 (Explosives). In addition, small airguns would create underwater impulsive noise during a small number of pierside integrated swimmer defense testing activities at pierside locations at Joint Expeditionary Base Little Creek, Norfolk, Virginia, and at Newport, Rhode Island, and during Stationary Source Testing at Naval Surface Warfare Center, Panama City Division Testing Range, as described in Table 2.8-3 and Section 3.0.5.3.1.4 (Swimmer Defense Airguns), and are included here because they produce underwater impulsive sound.

Although the impacts to birds are expected to increase under Alternative 1 compared to the No Action Alternative, the expected impacts on any individual bird would remain the same. For the same reasons provided in Section 3.6.3.1.2.1 (No Action Alternative), long-term impacts and potential mortality to a few individuals, and other short-term startle reactions to dispersed training events, are not expected to result in population-level impacts. Potential impacts to ESA-listed species and critical habitat are expected to be substantially similar to those discussed under Alternative 2.

Pursuant to the ESA, the use of explosives and swimmer defense airguns during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed piping plover, Bermuda petrel, and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from explosives and other impulsive sources during testing activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.3 Impacts from Pile Driving

Impact pile driving and vibratory pile removal would occur during construction of an elevated causeway system during Joint Logistics Over-the-Shore training. A separate environmental assessment has been prepared to address impacts due to all activities that occur during Joint Logistics Over-the-Shore training, with the exception of impacts due to in-water noise generated during construction of the elevated causeway. This EIS/OEIS includes analysis of the impact of underwater noise generated by pile driving during elevated causeway construction to facilitate holistic analysis of impacts due to all underwater noise generated during testing and training in the Study Area.

Impact pile driving and vibratory pile removal would create underwater sound in nearshore areas where some birds forage. Birds that forage by going under the water surface, such as by plunge-diving, could be exposed to these sounds. Potential impacts from pile driving are considered in the context of Section 3.0.5.7.1 (Conceptual Framework for Assessing Effects from Sound-Producing Activities). Noises produced during pile driving are discussed in Section 3.0.5.3.1.3 (Pile Driving).

Underwater impulses from the impact hammer are broadband and carry most of their energy in the lower frequencies. The impulses are within the hearing range of most seabirds and can produce a shock wave that is transmitted through the sediment and water column (Section 3.0.5.3.1.3, Pile Driving). Exposure to high sound pressure levels from pile driving can result in barotrauma, or physical injury caused by a difference in pressure between an air space inside the body and the surrounding gas or liquid. In addition, high sound exposure levels could potentially cause a threshold shift, temporarily or permanently affecting hearing sensitivity over the affected frequency range.

It is expected that some birds may exhibit an annoyance reaction and flee from the pile driving location; however, others may continue to forage close to the construction area and be exposed to associated noise. If prey species, such as fish, could be killed or injured as a result of pile driving, they could serve as an attractant and compound the issue of underwater noise exposure of birds that forage underwater. Behavioral responses and displacement from the area are expected to be temporary for the duration of the pile driving and removal activities.

Sound produced from a vibratory hammer is similar in frequency range to that of the impact hammer, except the source levels are much lower. Since the vibrations oscillate at a rate of 1,700 cycles per minute, it is considered a continuous sound source. The potential for injury is considered to be less than that for impact pile driving, and it is considered unlikely that seabirds would be exposed to injurious levels of sound from the vibratory hammer. Any avoidance of the area is expected to be temporary and is expected to occur only while the vibratory hammer is in use. There may be potential for masking of underwater sounds during underwater foraging; however, it is unknown to what extent birds present in the Study Area may rely on underwater sounds during foraging.

3.6.3.1.3.1 No Action Alternative

<u>Training Activities</u>

Under the No Action Alternative, pile driving would not occur during training activities.

<u>Testing Activities</u>

Under the No Action Alternative, pile driving would not occur during testing activities.

3.6.3.1.3.2 Alternative 1

Training Activities

Pile driving would occur during the construction and removal phases of the elevated causeway training activities nearshore and within the surf zone at Joint Expeditionary Base Little Creek–Fort Story, Virginia Beach, Virginia or Marine Corps Base Camp Lejeune, North Carolina. Elevated causeway construction would occur no more than once a year at one location. Training involves the use of an impact hammer to drive the piles into the sediment and a vibratory hammer is used to remove the piles. Construction activity would last about two weeks, with about eight piles driven per day. When training events that use the elevated causeway system are complete, the structure would be removed using vibratory methods over approximately seven to ten days. Crews can remove about 14 piles per day. Piles are driven and removed individually (i.e., not simultaneously).

Diving birds may potentially be exposed to underwater sounds from pile driving. Potentials for injury, hearing loss, or behavioral reactions due to pile driving and removal are expected to be low because individual pile driving and removal occurs over a short period (about 10 minutes per pile) and bird dives are usually brief. Birds that undertake longer dives could have a greater potential to be exposed to injurious levels of sound exposure. If a bird is exposed underwater at a close range, it could be injured or experience impacts to its hearing. Injury could reduce fitness and long-term survival. Impacts to the ability to sense biologically important sounds, such as predators or prey, could also be a long-term consequence, reducing that animal's fitness.

Behavioral reactions to in-water sound are expected to include alert responses, startle responses, or temporary increases in heart rate. Some birds may avoid the area during pile driving activities, which occur intermittently for a two-week period at a site. There may be potential for masking of underwater sounds during underwater foraging; however, it is unknown to what extent birds present in the Study Area may rely on underwater sounds during foraging. Startle reactions and temporary avoidance may disrupt foraging in the vicinity of the pile driving activity, however, these impacts are expected to only occur for the duration of the pile driving activity, which would only occur once per year and for brief periods of time during each construction day. For these reasons, the impact of noise produced by pile driving on birds under Alternative 1 would be short-term and localized, and is not expected to have any population-level impacts.

Bermuda petrels and red knots are highly unlikely to be present in coastal areas where pile driving would occur. Piping plovers and red knots do not submerge while foraging; therefore, they would not be exposed to underwater sound from pile driving. Roseate terns may briefly submerge while foraging, so there is a remote chance that a roseate tern could be exposed to underwater sound from pile driving and may avoid foraging in areas around the pile driving site for the duration of the activity. Pile driving activities would not occur at beaches that are designated as piping plover critical habitat.

Pursuant to the ESA, pile driving during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed roseate tern and piping plover;*
- *will have no effect on the ESA-listed Bermuda petrel;*
- *will have no effect on the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from pile driving during training activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under Alternative 1, pile driving would not occur during testing activities.

3.6.3.1.3.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be identical as described in Section 3.6.3.1.3.2 (Alternative 1).

Pursuant to the ESA, pile driving during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed roseate tern and piping plover;*
- *will have no effect on the ESA-listed Bermuda petrel;*
- *will have no effect on the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from pile driving during training activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Under Alternative 2, pile driving would not occur during testing activities.

3.6.3.1.4 Impacts from Weapons Firing, Launch, and Impact Noise

Navy activities in the Study Area include firing or launching a variety of weapons, including missiles; rockets; and small-, medium-, and large-caliber projectiles. Types of weapons firing activities, the sounds they produce, and areas where weapons firing are most likely to occur are described in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Because most weapons firing activities occur far from shore, seabirds that forage or migrate greater than 3 nm offshore are most likely to hear and respond to weapons firing noise. In addition to noise from weapons firing and launching, birds could be briefly disturbed by the impact of non-explosive practice munitions at the water surface.

Sounds produced by weapons firing (muzzle blast), launch boosters, and projectile travel are potential stressors to birds. Sound generated by a muzzle blast is intense, but very brief. A seabird very close to a large weapons blast could be injured or experience hearing loss due to acoustic trauma or threshold shift. Sound generated by a projectile travelling at speeds greater than the speed of sound can produce a sonic boom in a narrow area around its flight path. Bird responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. Once surface weapons firing activities begin, birds would likely disperse away from the area around the ship and the path of projectiles.

Other activities in the general area that precede these activities, such a vessel movement or target setting, potentially would disperse birds away from the area in which weapons-firing noise would occur. Species such as frigatebirds and sooty terns seem to avoid vessels (Borberg et al. 2005; Hyrenbach 2006). Any increased ship activity at a critical time or in an important foraging area could drive these and other species from their natural habitat (Borberg et al. 2005). On the other hand, some birds commonly follow vessels, including certain species of gulls, storm petrels, and albatrosses (Hamilton III 1958; Hyrenbach 2001, 2006). A number of seabird species are attracted to ships because of the increased potential for foraging success (Dietrich and Melvin 2004; Melvin et al. 2001). The propeller wake generated by all ships, but particularly larger ships, disrupts the water column, causing prey to be brought to the surface where it is more easily captured by a greater variety of seabird species. Seabirds that are attracted to ships are more likely to be exposed to weapons firing noise.

Airborne weapons firing at airborne targets typically occur at high altitudes of 15,000 to 25,000 ft. during air-to-air gunnery exercises. Noise generated by firing at such high altitudes is unlikely to generate a strong reaction in birds migrating at lower altitudes or foraging at the surface. The altitudes at which migrating birds fly can vary greatly based on the type of bird, where they are flying (over water or over land), and other factors such as weather. Approximately 95 percent of bird flight during migrations occurs below 10,000 ft. (3,048 m) with the majority below 3,000 ft. (914 m) (Lincoln 1998). While there is considerable variation, the favored altitude for most small birds appears to be between 500 ft. (152 m) and 1,000 ft. (305 m).

3.6.3.1.4.1 No Action Alternative

Training Activities

Weapons firing, launch, and non-explosive impact noise would be associated with small-, medium-, and large-caliber munitions; missiles; and bombs (non-explosive impact) used during training under the No Action Alternative. Activities are spread throughout the Study Area but would be concentrated in VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes, as described in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). The types of noise produced are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise).

Exposure of seabirds to weapons firing, launch, and impact noise would be very brief and temporary. Bird responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. While an individual bird may be exposed to multiple noises during a weapons firing activity, repeated exposures to individual birds over days is extremely unlikely. Both birds and Navy vessels change location frequently, and weapons firing and launch activities occur over short periods of time. Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds (unless they are very close to the muzzle blast). Activities with multiple weapons blasts may cause birds to disperse from the area for the duration of the firing activity. Because weapons firing activities would not occur close to shore where seabird colonies are located, large impacts on breeding seabird populations would not result from weapons-firing noise. For these reasons, the impact on seabirds of noise produced by weapons firing under the No Action Alternative would be minor and short-term and would not have any population-level impacts.

Because weapon firing occurs at varying locations over a short time period and seabird presence changes seasonally and on a short-term basis, individual birds would not be expected to be repeatedly exposed to weapons firing, launch, or projectile noise. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations.

ESA-listed or candidate species could be exposed to and temporarily disturbed by weapons firing and associated noise. Birds that migrate or forage in open ocean areas could be exposed to weapons firing, launch, and impact noise, including foraging and migrating Bermuda petrels; migrating roseate terns; and migrating red knots. Temporary disturbance due to weapons noise is not expected to result in major impacts on these ESA-listed or candidate species. Because weapons firing would occur offshore, roseate tern nesting colonies in the Key West Range Complex are unlikely to be disturbed. Piping plovers would not be present in the offshore areas where weapons are fired; additionally, weapons firing noise would not overlap with piping plover critical habitat.

Pursuant to the ESA, weapons firing, launch, and impact noise generated during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from weapons firing, projectile, launch, and impact noise during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Weapons firing, launch, and non-explosive impact noise would be associated with small-, medium-, and large-caliber munitions; missiles; rockets; and bombs (non-explosive impact) used during testing under the No Action Alternative. Activities are spread throughout the Study Area but would be concentrated in VACAPES and JAX Range Complexes, with events in the GOMEX and Northeast Range Complexes, as described in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). The types of noise produced are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise).

Exposure of seabirds to weapons firing, projectile noise, and launch noise would be very brief and temporary. Bird responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. While an individual bird may be exposed to multiple noises during a weapons-firing activity, repeated exposures to individual birds over days is extremely unlikely. Both birds and Navy vessels change location frequently, and weapons firing and launch activities occur over short periods. Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds (unless they are very close to the muzzle blast). Activities with multiple weapons blasts may cause birds to disperse from the area for the duration of the firing activity. Because weapons-firing activities would not occur close to shore where seabird colonies are located, large impacts on breeding seabird populations would not result from weapons-firing noise. For these reasons, the impact of noise produced by weapons firing on seabirds under the No Action Alternative would be minor and short-term, and would not have any population-level impacts.

Because weapon firing occurs at varying locations over a short period and seabird presence changes seasonally and on a short-term basis, individual birds would not be expected to be repeatedly exposed to weapons firing, launch, or projectile noise. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations.

ESA-listed or candidate species could be exposed to and temporarily disturbed by weapons firing and associated noise. Birds that migrate or forage in open ocean areas could be exposed to weapons firing, launch, and impact noise, including foraging and migrating Bermuda petrels; migrating roseate terns; and migrating red knots. Temporary disturbance due to weapons noise is not expected to result in major impacts on these ESA-listed or candidate species. Because weapons firing would occur offshore, roseate tern nesting colonies in the Key West Range Complex are unlikely to be disturbed. Piping plovers would not be present in the offshore areas where weapons are fired; additionally, weapons firing noise would not overlap with piping plover critical habitat.

Pursuant to the ESA, weapons firing, launch, and impact noise generated during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from weapons firing, projectile, launch, and impact noise during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.4.2 Alternative 1

Training Activities

Weapons firing, launch, and non-explosive impact noise would be associated with small-, medium-, and large-caliber munitions; missiles; and bombs (non-explosive impact) used during training under Alternative 1. Activities are spread throughout the Study Area but would be concentrated in VACAPES, Navy Cherry Point, JAX, and Gulf of Mexico Range Complexes, as described in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). The types of noise produced are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Due to increased numbers of activities, noise produced by these activities would increase under Alternative 1 compared to the No Action Alternative.

Exposure of seabirds to weapons firing, launch, and impact noise would be very brief and temporary. Bird responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. While an individual bird may be exposed to multiple noises during a weapons firing activity, repeated exposures to individual birds over days is extremely unlikely. Both birds and Navy vessels change location frequently, and weapons firing and launch activities occur over short periods. Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds (unless they are very close to the muzzle blast). Activities with multiple weapons blasts may cause birds to disperse from the area for the duration of the firing activity. Because weapons firing activities would not occur close to shore where seabird colonies are located, large impacts on breeding seabird populations would not result from weapons firing noise. For these reasons, the impact of noise produced by weapons firing on seabirds under Alternative 1 would be minor and short-term and would not have any population-level impacts.

Because weapons firing occurs at varying locations over a short time and seabird presence changes seasonally and on a short-term basis, individual birds would not be expected to be repeatedly exposed to weapons firing, launch, or projectile noise. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations.

ESA-listed or candidate species could be exposed to and temporarily disturbed by weapons firing and associated noise. Birds that migrate or forage in open ocean areas could be exposed to weapons firing, launch, and impact noise, including foraging and migrating Bermuda petrels; migrating roseate terns; and migrating red knots. Temporary disturbance due to weapons noise is not expected to result in major impacts on these ESA-listed or candidate species. Because weapons firing would occur offshore, roseate tern nesting colonies in the Key West Range Complex are unlikely to be disturbed. Piping plovers would not be present in the offshore areas where weapons are fired; additionally, weapons firing noise would not overlap with piping plover critical habitat.

Pursuant to the ESA, weapons firing, launch, and impact noise generated during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from weapons firing, projectile, launch, and impact noise during training activities described under the Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Weapons firing, launch, and non-explosive impact noise would be associated with small-, medium-, and large-caliber munitions; missiles; rockets; and bombs (non-explosive impact) used during testing under Alternative 1. Activities are spread throughout the Study Area but would be concentrated in VACAPES and JAX Range Complexes, with events in the Northeast and GOMEX Range Complexes, as described in Tables 2.8-2 to 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). The types of noise produced are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Noise produced by these activities would substantially increase under Alternative 1 compared to the No Action Alternative.

Exposure of seabirds to weapons firing, and launch noise would be very brief and temporary. Bird responses to weapons-firing and projectile travel noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. While an individual bird may be exposed to multiple noises during a weapons firing activity, repeated exposures to individual birds over days is extremely unlikely. Both birds and Navy vessels change location frequently, and weapons firing and launch activities occur over short periods. Startle or alert reactions to muzzle blasts are not likely to disrupt major behavior patterns such as migrating, breeding, feeding, and sheltering or to result in serious injury to any seabirds (unless they are very close to the muzzle blast). Activities with multiple weapons blasts may cause birds to disperse from the area for the duration of the firing activity. Because weapons firing activities would not occur close to shore where seabird colonies are located, large impacts on breeding seabird populations would not result from weapons firing noise. For these reasons, the impact of noise produced by weapons firing on seabirds under Alternative 1 would be minor and short-term, and are not expected to have any population-level impacts.

Because weapon firing occurs at varying locations over a short period and seabird presence changes seasonally and on a short-term basis, individual birds would not be expected to be repeatedly exposed to weapons firing, launch, or projectile noise. Any impacts on migratory or breeding seabirds related to startle reactions, displacement from a preferred area, or reduced foraging success in offshore waters would likely be short-term and infrequent and would not impact seabird or migratory bird populations.

ESA-listed or candidate species could be exposed to and temporarily disturbed by weapons firing and associated noise. Birds that migrate or forage in open ocean areas could be exposed to weapons firing, launch, and impact noise, including foraging and migrating Bermuda petrels; migrating roseate terns; and migrating red knots. Temporary disturbance due to weapons noise is not expected to result in major impacts on these ESA-listed or candidate species. Because weapons firing would occur offshore, roseate tern nesting colonies in the Key West Range Complex are unlikely to be disturbed. Piping plovers would not be present in the offshore areas where weapons are fired; additionally, weapons firing noise would not overlap with piping plover critical habitat.

Pursuant to the ESA, weapons firing, launch, and impact noise generated during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from weapons firing, projectile, launch, and impact noise during testing activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.4.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be identical as described in Section 3.6.3.1.4.2 (Alternative 1).

Pursuant to the ESA, weapons firing, launch, and impact noise generated during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from weapons firing, projectile, launch, and impact noise during training activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Weapons firing, launch, and non-explosive impact noise would be associated with small-, medium-, and large-caliber munitions; missiles; rockets; and bombs (non-explosive impact) used during testing under Alternative 2. Activities are spread throughout the Study Area but would be concentrated in VACAPES and JAX Range Complexes, with events in the Northeast and GOMEX Range Complexes, as described in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives). The types of noise produced are discussed in Section 3.0.5.3.1.5 (Weapons Firing, Launch, and Impact Noise). Noise produced by these activities would substantially increase under Alternative 2 compared to the No Action Alternative. The number of testing events producing weapons noise under Alternative 2 would increase by approximately 10 percent over Alternative 1.

Although more birds could be exposed to weapons noise under Alternative 2 than under the No Action Alternative, the types of impacts to individual birds are expected to be the same. Although individual birds may exhibit short-term behavioral reactions, long-term impacts to populations are not expected. In addition, although exposures to weapons noise impacts to ESA-listed Bermuda petrels and roseate terns and ESA-candidate red knots may increase, the types of impacts are not expected to differ from those discussed under Alternative 1.

Pursuant to the ESA, weapons firing launch, and impact noise generated during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from weapons firing, projectile, launch, and impact noise during testing activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.5 Impacts from Aircraft and Vessel Noise

Various types of fixed-wing aircraft, helicopters, and vessels are used in most training and testing activities throughout the Study Area. Therefore, seabirds and other migratory birds could be exposed to airborne noise associated with fixed-wing aircraft overflights (subsonic and supersonic), helicopter activities, and vessels throughout the Study Area. See Section 3.0.5.3.1.7 (Aircraft Overflight Noise) for a description of aircraft noise generated during training and testing activities.

Responses to airborne noise could include short-term behavioral or physiological reactions, such as alert response, startle response, or temporary increase in heart rate, which are likely to be more acute for sonic boom exposures. Maximum behavioral responses by crested tern (*Sterna bergii*) to aircraft noise were observed at sound level exposures greater than 85 dBA re 20 µPa. While the experiment provided good control on simulated aircraft noise levels, preliminary observations of tern colonies responses to balloon overflights suggest that visual stimulus is likely to be an important component of disturbance from overflights (Brown 1990). Raptor and wading birds have responded minimally to jet (100-110 dBA re 20 µPa) and propeller plane (92 dBA re 20 µPa) overflights, respectively (Ellis 1981). Jet flights greater than 1,640 ft. (500 m) distance from raptors were observed to elicit no response (Ellis 1981). However, herring gulls (*Larus argentatus*) significantly increased their aggressive interactions within the colony and their flights over the colony during overflights with received sound levels of 101–116 dBA re 20 µPa (Burger 1981). The impacts of low-level military training flights on wading bird colonies in Florida were estimated using colony distributions and turnover rates. There were no demonstrated impacts of military activity on wading bird colony establishment or size (Black et al. 1984). Fixed-winged jet aircraft disturbance did not seem to adversely affect waterfowl observed during a study in coastal North Carolina (Conomy et al. 1998); however, harlequin ducks were observed to show increased agonistic behavior and reduced courtship behavior up to one to two hours after low altitude military jet overflights (Goudie and Jones 2004).

Masking is another potential impact of exposure to aircraft or vessel noise. Aircraft and vessel noise may temporarily interfere with detection of conspecifics, predators, and prey.

Most activities using fixed-wing aircraft occur at distances greater than 12 nm offshore. Birds could be exposed to elevated noise levels while foraging or migrating in these open water environments. Most fixed-wing sorties would occur greater than 3,000 ft. altitude and would be associated with air combat maneuver training, tracking exercises, and aircraft testing. Typical altitudes would range from 5,000 to 30,000 ft., and typical airspeeds would range from very low (less than 100 knots) to high subsonic (less than 600 knots). Sound exposure levels at the sea surface from most air combat maneuver overflights are expected to be less than 85 dBA re 20 µPa, based on an F/A-18 aircraft flying at an altitude of 5,000 ft. and at a subsonic airspeed of 400 knots. Exceptions include sorties associated with air-to-surface munitions delivery and sonobuoy drops from 500 to 5,000 ft. altitude. Bird exposure to fixed-wing aircraft noise would be brief (seconds) as an aircraft quickly passes overhead.

Some air combat maneuver training would involve high altitude, supersonic flight, which would produce sonic booms, but such airspeeds would be infrequent. Boom duration is generally less than 300 milliseconds. Sonic booms would cause birds to startle, but the exposure would be brief, and any reactions are expected to be short-term. Startle impacts range from altering behavior (e.g., stop feeding or preening), minor behavioral changes (e.g., head turning), or at worst, a flight response. Because most fixed-wing flights are not supersonic and both seabirds and aircraft are transient in any area, exposure of seabirds in the open ocean to sonic booms would be infrequent. It is unlikely that individual seabirds would be repeatedly exposed to sonic booms in the open ocean.

Birds could sensitize or habituate to repeated exposures to sonic booms and aircraft noise. Habituation seems unlikely in the open water portions of the Study Area given the widely dispersed nature of the operations and the relative infrequency of the activities. Repeated exposures could occur to populations that are not transient, such as nesting birds. It is possible that birds could habituate and no longer exhibit behavioral responses, as has been documented for some impulsive noise sources (Ellis 1981; Russel Jr. et al. 1996) and aircraft noise (Conomy et al. 1998). It is also possible that birds could sensitize from routinely flushing when hearing the noise to completely abandoning an area. Near-total failure of sooty tern nesting in the Dry Tortugas in the Key West Range Complex was reported in 1969 during a period when the birds were regularly exposed to sonic booms (Austin et al. 1970). In previous seasons, the birds were reported to react to the occasional sonic booms by rising immediately in a "panic flight," circling over the island, and then usually settling down on their eggs again. Researchers had no evidence that sonic booms caused physical damage to the sooty tern eggs, but hypothesized that the strong booms occurred often enough to disturb the sooty terns' incubating rhythm and cause nest desertion. The 1969 sooty tern nesting failure also prompted additional research to test the hypothesis that sonic booms could cause bird eggs to crack or otherwise affect bird eggs or embryos. However, the findings of the additional research were contrary to this hypothesis (Bowles et al. 1991; Bowles et al. 1994; Teer and Truett 1973; Ting et al. 2002). That same year, the colony also contained approximately 2,500 brown noddies, whose young hatched successfully. While it was impossible to conclusively determine the cause of the 1969 sooty tern nesting failure, actions were taken to curb planes breaking the sound barrier within range of the Tortugas, and much of the excess vegetation was cleared (another hypothesized contributing factor to the nesting failure). Similar nesting failures have not been reported since the 1969 failure.

Currently, the Tortugas Military Operations Area is a unique block of special use airspace above the Dry Tortugas National Park that has special flight rules designed to minimize military aircraft noise. Voluntary flight restrictions include a "no sonic boom" area over the Dry Tortugas and a 5,000-ft. (1.5-km) aboveground level floor for air combat maneuver flights. The "no sonic boom" area, which extends 12 nm and 20,000 ft. (6.1 km) above ground level from the Dry Tortugas, limits aircraft to subsonic speeds within this area. Audible sonic booms within the Dry Tortugas National Park are predicted to be infrequent and at low received levels based on voluntary measures implemented by the Navy to reduce the occurrence of focused sonic booms in the Tortugas Military Operations Area. In addition, initial efforts by Florida Fish and Wildlife Conservation Commission and National Park Service biologists to reestablish a nesting colony of the federally listed roseate tern in the Dry Tortugas have been successful. During this time, Navy use of the Tortugas Military Operations Area and surrounding

Special Use Airspace remained constant. National Park Service staff recorded 25 sonic booms in 2007 and 40 in 2008. Given the increase in nests coincident with air combat maneuver training, the aircraft training following guidelines of the Military Operations Area has likely had minimal impact on nesting roseate terns.

Unlike fixed-wing aircraft, helicopters typically operate below 1,000 ft. altitude and often as low as 75–100 ft. altitude. This low altitude increases the likelihood that birds would respond to noise from helicopter overflights. Helicopters travel at slower speeds (less than 100 knots), which increases durations of noise exposure compared to fixed-wing aircraft. In addition, some studies have suggested that birds respond more to noise from helicopters than from fixed-wing aircraft (Larkin et al. 1996). Helicopter flights are generally limited to locations closer to the coast, unless deployed onboard ships. Helicopter flights, therefore, are more likely to impact the greater numbers of seabirds that forage in coastal areas than those that forage in open ocean areas. Nearshore areas of the coast are the primary foraging habitat for many seabird species. Noise from low-altitude helicopter overflights may elicit short-term behavioral or physiological responses, such as alert responses, startle responses, or temporary increases in heart rate, in exposed birds. Repeated exposure of individual birds or groups of birds is unlikely, based on the dispersed nature of the overflights. The general health of individual birds would not be compromised.

Foraging seabirds as well as most migrating birds would be present below the altitude of fixed-wing flights, but could potentially be exposed to nearby noise from helicopters at lower altitudes. Altitudes at which migrating birds fly can vary greatly based on the type of bird, where they are flying (over water or over land), and other factors such as weather. Approximately 95 percent of bird flight during migrations occurs below 10,000 ft. (3,048 m) with the majority below 3,000 ft. (914 m) (Lincoln et al. 1998). While there is considerable variation, the favored altitude for most small birds appears to be between 500 ft. (152 m) and 1,000 ft. (305 m) (Lincoln et al. 1998).

Naval combat vessels are designed to be quiet to avoid detection; therefore, any disturbance to birds is expected to be due to visual, rather than acoustic, stressors. Other training and testing support vessels, such as rigid hull inflatable boats, use outboard engines that can produce substantially more noise even though they are much smaller than warships. Noise due to watercraft with outboard engines or noise produced by larger vessels operating at high speeds may briefly disturb some birds while foraging or resting at the water surface. However, the responses due to both acoustic and visual exposures are likely related and difficult to distinguish.

3.6.3.1.5.1 No Action Alternative

Training Activities

Training activities under the No Action Alternative include fixed- and rotary-wing aircraft overflights and vessel movements throughout the Study Area. The highest concentrations of fixed-wing aircraft noise would be associated with the greater number of flights in the VACAPES and Key West Range Complexes compared to other portions of the Study Area. Most helicopter training would occur adjacent to fleet concentration areas at Naval Station Norfolk (lower Chesapeake Bay and off the coast of Virginia Beach, Virginia) and at Naval Station Mayport, Jacksonville, Florida; in Onslow Bay, North Carolina; and off the coast of Naval Surface Warfare Center, Panama City Division Testing Range. Concentrations of vessel movements throughout the Study Area are discussed in Section 3.0.5.3.3.1 (Vessels).

Birds using wetlands, mud flats, beaches, and other shoreline habitats or shallow coastal foraging areas would be exposed to noise from nearshore helicopter training and aircraft in transit to offshore training areas. The presence of dense aggregations of sea ducks, other seabirds, and migrating land birds is a potential concern during low-altitude helicopter activities. Although birds may be more likely to react to helicopters than to fixed-wing aircraft, Navy helicopter pilots avoid large flocks of birds to protect aircrews and equipment, thereby reducing disturbance to birds as well.

Navy aircraft training activities over the Atlantic Ocean are concentrated near the outer continental shelf and the Gulf Stream. Pelagic seabirds that forage offshore may have greater presence in these productive areas, so aircraft overflights may cause more behavioral disturbances in these areas. A seabird in the open ocean would be exposed for a few seconds to fixed-wing aircraft noise as the aircraft quickly passes overhead. Seabirds foraging or migrating through a training area in the open ocean may respond by avoiding areas of concentrated aircraft noise. Exposures to most seabirds would be infrequent, based on the brief duration and dispersed nature of the overflights.

Seabirds and migratory birds may be exposed to sonic booms infrequently while flying or foraging in the Study Area or while feeding, perching, or nesting on one of the islands in the Dry Tortugas or the Marquesas Keys in the Key West Range Complex. In the Key West Range Complex, Navy Special Use Airspace surrounds the Tortugas Military Operations Area, and air combat maneuver training occurs regularly in the Special Use Airspace above and beside the Military Operations Area. Consequently, aircraft noise, including sonic boom noise, is sometimes audible in the Dry Tortugas National Park. Wintering piping plovers and nesting roseate terns could be exposed to noise associated with aircraft overflights, including sonic booms, in the vicinity of the Dry Tortugas or the Marquesas Keys. Aircraft overflights are expected to elicit short-term behavioral responses in nesting birds at Dry Tortugas National Park. Chronic stress, nest abandonment, or population-level impacts are not expected to occur. Similarly, aircraft overflights are expected to elicit short-term behavioral responses in birds at Marquesas Keys based on their location on the extreme eastern boundary of W-174E in the Key West Range Complex, where fewer low-altitude overflights occur in comparison to other Special Use Airspace blocks. Based on current airspace usage and bird presence, routine flushing during the nesting season or abandonment of a nesting area would not be expected.

Although noise associated with vessel movements would be produced during most sea-based training activities, the most acute noise exposure would be expected from small craft using outboard engines. Any vessel noise disturbance is expected to be very brief and inconsequential. Any reactions may be due more to visual detection of an approaching vessel than to acoustic disturbance.

Occasional startle or alert reactions to aircraft and vessels are not likely to disrupt major behavior patterns (such as migrating, breeding, feeding, and sheltering) or to result in serious injury to any seabirds. Helicopter overflights would be more likely to elicit responses than fixed-wing aircraft, but the general health of individual birds would not be compromised. For these reasons, the impact of noise produced by Navy aircraft and vessels on seabirds under the No Action Alternative would be minor and short-term. Short-term impacts on individual birds are not expected to impact seabird populations.

ESA-listed or candidate birds may be exposed to vessel and aircraft noise. Coastal roseate terns, red knots, and piping plovers could be exposed to intermittent aircraft noise from aircraft originating from airfields located along the coast and vessel noise from nearshore boats. If present in the open water areas where training activities involving aircraft overflights occur, roseate terns, red knots, and Bermuda petrels could be temporarily disturbed while foraging or migrating. Short-term behavioral responses such as startle responses, head turning, or flight responses would be expected. Repeated exposures would be limited due to the transient nature of aircraft use and regular movement of seabirds. No long-term or population-level impacts are expected. Critical habitat for wintering piping plovers is designated in the Marquesas Keys. Although there could be intermittent increases in ambient noise levels, aircraft overflights would not impact the ability of critical habitat designated in the Marquesas Keys to support roosting, refuge, or feeding of wintering piping plovers.

Pursuant to the ESA, aircraft and vessel noise generated during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from aircraft and vessel noise during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Testing activities under the No Action Alternative include fixed- and rotary-wing aircraft overflights and vessel movements throughout the Study Area. Aircraft flights associated with testing are primarily concentrated within the VACAPES, Navy Cherry Point, and JAX Range Complexes, although aircraft flights associated with testing activities would also be concentrated in the Northeast Range Complexes, including adjacent inland waters, and in the Gulf of Mexico, especially in areas near Naval Surface Warfare Center, Panama City Division Testing Range. Concentrations of vessel movements throughout the Study Area are discussed in Section 3.0.5.3.3.1 (Vessels).

Birds using wetlands, mud flats, beaches, and other shoreline habitats or shallow coastal foraging areas would be exposed to noise from nearshore helicopters and aircraft in transit to offshore areas. The presence of dense aggregations of sea ducks, other seabirds, and migrating land birds is a potential concern during low-altitude helicopter activities. Although birds may be more likely to react to helicopters than to fixed-wing aircraft, Navy helicopter pilots avoid large flocks of birds to protect aircrews and equipment, thereby reducing disturbance to birds.

Navy aircraft testing activities over the Atlantic Ocean are concentrated near the outer continental shelf and the Gulf Stream. Pelagic seabirds that forage offshore may have greater presence in these productive areas, so aircraft overflights may cause more behavioral disturbances in these areas.
A seabird in the open ocean would be exposed for a few seconds to fixed-wing aircraft noise as the aircraft quickly passes overhead. Seabirds foraging or migrating through a testing area in the open ocean may respond by avoiding areas of concentrated aircraft noise. Exposures to most seabirds would be infrequent, based on the brief duration and dispersed nature of the overflights. Although noise associated with vessel movements would be produced during most sea-based testing activities, the most acute noise exposure would be expected from small craft using outboard engines. Any vessel noise disturbance is expected to be very brief and inconsequential. Any reactions may be due more to visual detection of an approaching vessel than to acoustic disturbance.

Occasional startle or alert reactions to aircraft and vessels are not likely to disrupt major behavior patterns, such as migrating, breeding, feeding, and sheltering, or to result in serious injury to any seabirds. Helicopter overflights would be more likely to elicit responses than fixed-wing aircraft, but the general health of individual birds would not be compromised. For these reasons, the impact of noise produced by Navy aircraft and vessels on seabirds under the No Action Alternative would be minor and short-term. None of these noise exposures are expected to impact bird populations.

If present in the open water areas where testing activities involving aircraft overflights occur, roseate terns and Bermuda petrels could be temporarily disturbed while foraging or migrating. Short-term behavioral responses such as startle responses, head turning, or flight responses would be expected. Repeated exposures would be limited due to the transient nature of aircraft use and regular movement of seabirds. Short-term impacts on individual birds are not expected to impact seabird populations.

ESA-listed or candidate birds may be exposed to vessel and aircraft noise. Coastal roseate terns, red knots, and piping plovers could be exposed to intermittent aircraft noise from aircraft originating from airfields located along the coast and vessel noise from nearshore boats. If present in the open water areas where testing activities involving aircraft overflights occur, roseate terns, red knots, and Bermuda petrels could be temporarily disturbed while foraging or migrating. Short-term behavioral responses such as startle responses, head turning, or flight responses would be expected. Repeated exposures would be limited due to the transient nature of aircraft use and regular movement of seabirds. No long-term or population-level impacts are expected. Critical habitat for wintering piping plovers is designated in the Marquesas Keys. Although there could be intermittent increases in ambient noise levels, aircraft overflights would not impact the ability of critical habitat designated in the Marquesas Keys to support roosting, refuge, or feeding of wintering piping plovers.

Pursuant to the ESA, aircraft and vessel noise generated during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from aircraft and vessel noise during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.5.2 Alternative 1

Training Activities

Training activities proposed under Alternative 1 would increase aircraft flight hours and vessel transits compared to the No Action Alternative. The locations and types of activities are expected to be similar to those under the No Action Alternative.

Although overall aircraft and vessel noise would increase over the No Action Alternative, impacts on individual birds would be similar. Based on the increased activities under Alternative 1, more birds could be exposed to noise; the number of times an individual bird is exposed could also increase. Similar to the No Action Alternative, responses are expected to be short-term behavioral or physiological reactions, but the general health of individual birds is not expected to be compromised. Short-term impacts on individual birds are not expected to impact seabird populations. Although noise due to aircraft flights and vessel transits would increase, impacts on ESA-listed species and critical habitat would be similar as under the No Action Alternative.

Pursuant to the ESA, aircraft and vessel noise generated during training activities under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from aircraft and vessel noise during training activities described under the Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Testing Activities proposed under Alternative 1 would increase aircraft flights and vessel transits from the No Action Alternative, leading to an increase in aircraft- and vessel-related noise in some portions of the Study Area. Aircraft flights associated with testing are primarily concentrated within the VACAPES, Navy Cherry Point, and JAX Range Complexes, although aircraft flights associated with testing activities would also be concentrated in the Northeast Range Complexes, including adjacent inland waters, and in the Gulf of Mexico, especially in areas near Naval Surface Warfare Center, Panama City Division Testing Range, Florida.

Although overall aircraft noise would increase over the No Action Alternative, impacts on individual birds would be similar. Based on the increased activities under Alternative 1, more birds could be exposed to noise; the number of times an individual bird is exposed could also increase. Similar to the No Action Alternative, responses are expected to be short-term behavioral or physiological reactions, but the general health of individual birds is not expected to be compromised. Short-term impacts on individual birds are not expected to impact seabird populations. Although noise due to aircraft flights and vessel transits would increase, impacts on ESA-listed species and critical habitat would be similar as under the No Action Alternative.

Pursuant to the ESA, aircraft and vessel noise generated during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from aircraft and vessel noise during testing activities described under the Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.1.5.3 Alternative 2 (Preferred Alternative)

Training Activities

Training activities proposed under Alternative 2 would increase aircraft flight hours compared to the No Action Alternative, specifically due to a 20 percent increase in air combat maneuvers in the Key West Range Complex. Other than the increase in noise generated by the increase in flight hours at Key West Range Complex, the number and location of training activities producing aircraft and vessel noise under Alternative 2 are identical to training activities under Alternative 1.

Although overall aircraft and vessel noise would increase over the No Action Alternative, impacts on individual birds would be similar. Based on the increased activities under Alternative 2, more birds could be exposed to noise; the number of times an individual bird is exposed could also increase. Similar to the No Action Alternative, responses are expected to be short-term behavioral or physiological reactions, but the general health of individual birds is not expected to be compromised. Short-term impacts on individual birds are not expected to impact seabird populations. Although noise due to aircraft flights and vessel transits would increase, impacts on ESA-listed species and critical habitat would be similar as under the No Action Alternative.

Pursuant to the ESA, aircraft and vessel noise generated during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from aircraft and vessel noise during training activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Testing Activities proposed under Alternative 2 would increase aircraft flights and vessel transits compared to both the No Action Alternative and Alternative 1, leading to an increase in aircraft- and vessel-related noise in some portions of the Study Area. Aircraft flights associated with testing are primarily concentrated within the VACAPES, Navy Cherry Point, and JAX Range Complexes, although aircraft flights associated with testing activities would also be concentrated in the Northeast Range Complexes, including adjacent inland waters, and in the Gulf of Mexico, especially in areas near Naval Surface Warfare Center, Panama City Division Testing Range, Florida.

Although overall aircraft and vessel noise would increase over the No Action Alternative, impacts on individual birds would be similar. Based on the increased operations under Alternative 2, more birds could be exposed to noise; the number of times an individual bird is exposed could also increase. Similar to the No Action Alternative, the responses would be limited to short-term behavioral or physiological reactions, and the general health of individual birds would not be compromised. Short-term impacts on individual birds are not expected to impact seabird populations. Although noise due to aircraft and vessels would increase over Alternative 1, the types of impacts on Bermuda petrels, piping plovers, red knots, and roseate terns, as well as to piping plover critical habitat, would not differ substantially from those under Alternative 1.

Pursuant to the ESA, aircraft and vessel noise generated during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, and roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from aircraft and vessel noise during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.2 Energy Stressors

This section analyzes the potential impacts of the various types of energy stressors that can occur during training and testing activities within the Study Area. This section includes analysis of the potential impacts from (1) electromagnetic devices, and (2) high energy lasers.

3.6.3.2.1 Impacts from Electromagnetic Devices

Several different types of electromagnetic devices are used during training and testing activities. Electromagnetic training and testing activities include an array of magnetic sensors used in mine countermeasure operations in the Study Area. For a discussion of the types of activities that use electromagnetic devices, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.2.1 (Electromagnetic Devices). Aspects of electromagnetic stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.2 (Conceptual Framework for Assessing Effects from Energy-Producing Activities).

Seabirds are known to use the Earth's magnetic field as a navigational cue during seasonal migrations (Akesson and Hedenstrom 2007; Fisher 1971; Wiltschko and Wiltschko 2005). Birds use numerous other orientation cues to navigate in addition to magnetic fields. These include position of the sun, celestial cues, visual cues, wind direction, and scent (Akesson and Hedenstrom 2007; Fisher 1971; Haftorn et al. 1988; Wiltschko and Wiltschko 2005). It is believed that by using a combination of these cues birds are able to successfully navigate long distances. A magnetite-based (magnetic mineral) receptor mechanism in the upper beak of birds provides information on position and compass direction (Wiltschko and Wiltschko 2005). Some electromagnetic devices such as a vessel radar and radio are devices that could impact birds above the water. Towed electromagnetic device impacts to birds would only occur underwater and would only impact diving species or species on the surface in the immediate area where the device is deployed. There is no information available on how birds react to electromagnetic fields underwater.

Studies conducted on electromagnetic sensitivity in birds have typically been associated with land, and little information exists specifically on seabird response to electromagnetic changes at sea. Results from a study conducted by Larkin and Sutherland (1977) showed that during nocturnal flights, birds were capable of sensing electromagnetic fields emitted from an antenna in Wisconsin used for the Navy's Project Seafarer. This study suggested that birds react to low intensity electromagnetic fields and changed their flight altitudes more frequently when the antenna was operational. Another study on the impacts of extremely low-frequency electromagnetic fields on breeding and migrating birds around the Navy's extra-low-frequency communication system antenna in Wisconsin found no evidence that bird distribution or abundance was impacted by electromagnetic fields produced by the antenna (Hanowski et al. 1993).

Possible impacts on birds from electromagnetic fields above water include behavioral responses such as temporary disorientation and change in flight direction (Larkin and Sutherland 1977; Wiltschko and Wiltschko 2005) and flight altitude (Larkin and Sutherland 1977). Many bird species return to the same stopover, wintering, and breeding areas every year and often follow the exact same or very similar migration routes (Akesson 2003; Alerstam et al. 2006). However, ample evidence exists that displaced birds can successfully reorient and find their way when one or more cues are removed (Akesson 2003; Haftorn et al. 1988). For example, Haftorn et al. (1988) found that after removal from their nests and release into a different area, snow petrels (*Pagodrama nivea*) were able to successfully navigate back to their nests even when their ability to smell was removed. Furthermore, Wiltschko and Wiltschko (2005) report that electromagnetic pulses administered to birds during an experimental study on orientation do not deactivate the magnetite-based receptor mechanism in the upper beak altogether but instead cause the receptors to provide altered information, which in turn causes birds to orient in different directions. However, these impacts were temporary, and the ability of the birds to correctly orient themselves eventually returned.

3.6.3.2.1.1 No Action Alternative

Training Activities

As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under the No Action Alternative, training activities involving electromagnetic devices occur in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area, specifically within the VACAPES, Navy Cherry Point, and JAX Range Complexes. Use of electromagnetic devices is concentrated within the VACAPES Range Complex.

The distribution of seabirds in these portions of the Study Area is patchy (Fauchald et al. 2002; Schneider and Duffy 1985). Exposure of birds would be limited to those foraging at or below the surface (e.g., terns, cormorants, loons, petrels, or grebes) because that is where the devices are used. Birds that forage inshore (e.g., piping plover or red knot) would not be exposed to these electromagnetic stressors because electromagnetic devices are not used in areas close to shore and are used only underwater. Also, the electromagnetic fields generated would be distributed over time and location, and any influence on the surrounding environment would be temporary and localized. More importantly, the electromagnetic devices used are typically towed by a helicopter and it is likely that any birds in the vicinity of the approaching helicopter would be dispersed by the sound and disturbance generated by the helicopter (Section 3.6.3.1.5, Impacts from Aircraft and Vessel Noise) and move away from the device before any exposure could occur.

Designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems; however, none of these areas overlap with the use of electromagnetic devices in the Study Area. Two of the primary constituent elements of critical habitat required by piping plover (i.e., sheltering and roosting) are applicable to their terrestrial beach habitats (above the high tide line), which are outside of the Study Area. The other primary constituent element is foraging. While piping plovers do forage in the intertidal portions of the Study Area, these areas do not overlap with any locations where electromagnetic devices are used. Therefore, none of the electromagnetic stressors will affect piping plover critical habitat.

In the unlikely event that a bird is temporarily disoriented by an electromagnetic device, it would still be able to re-orient using its internal magnetic compass to aid in navigation (Wiltschko et al. 2011). Therefore, any temporary disorientation experienced by birds from electromagnetic changes caused by training activities in the Study Area may be considered a short-term impact and would not hinder bird navigation abilities. Disorientation is only one potential effect; physiological effects such as increased body temperature could also result from electromagnetic devices. Other orientation cues may include position of the sun and moon, visual cues, wind direction, infrasound, and scent (Akesson and Hedenstrom 2007; Fisher 1971; Haftorn et al. 1988; Hagstrum 2013; Wiltschko and Wiltschko 2005).

Impacts on birds from potential exposure to electromagnetic devices would be temporary and inconsequential based on the: (1) relatively low intensity of the magnetic fields generated (0.2 microtesla at 656 ft. [200 m] from the source), (2) very localized potential impact area, (3) temporary duration of the activities (hours), and (4) occurrence only underwater. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under the No Action Alternative, testing activities involving electromagnetic devices occur in the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, specifically within the VACAPES Range Complex and Naval Surface Warfare Center, Panama City Division Testing Range. Activities using electromagnetic devices are concentrated within the Naval Surface Warfare Center, Panama City Division Testing Range.

Birds that forage inshore (e.g., piping plover or red knot) would not be exposed to these electromagnetic stressors because electromagnetic devices are not used in areas close to shore. For reasons stated in the training activities discussion in Section 3.6.3.2.1.1 (No Action Alternative) above, any behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Although designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, none of these areas overlap with the use of electromagnetic devices in the Study Area. Therefore, for reasons stated in the training activities, none of the electromagnetic stressors will affect piping plover critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.2.1.2 Alternative 1

Training Activities

As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, electromagnetic device use in the Study Area would increase by less than 2 percent compared to the No Action Alternative. Training activities involving electromagnetic devices would continue to occur in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area, specifically within VACAPES, Navy Cherry Point, and JAX Range Complexes. In addition, activities will be introduced within the Gulf of Mexico Large Marine Ecosystem, specifically within the GOMEX Range Complex, as well as in one of the following bays or inland waters: Sandy Hook Bay, Earle, New Jersey; lower Chesapeake Bay, Hampton Roads, Virginia; Beaufort Inlet Channel, Morehead City, North Carolina; Cape Fear River, Wilmington, North Carolina; St. Andrew Bay, Panama City, Florida; Sabine Lake, Beaumont, Texas; and Corpus Christi Bay, Corpus Christi, Texas. Electromagnetic device activities will remain concentrated within the VACAPES Range Complex. Bird species that occur in these areas, including all ESA-listed bird species and the ESA-candidate red knot, could be exposed to electromagnetic devices.

The increase in activities in previously identified locations, and introduction of activities in the additional locations as described above, would not measurably increase the probability of birds being exposed to electromagnetic energy as compared to the No Action Alternative. The differences in species overlap and potential impacts of electromagnetic devices on bird groups, ESA-listed species, and the ESA-candidate red knot during training activities would not be discernible from those described for training activities in Section 3.6.3.2.1.1 (No Action Alternative).

For reasons stated in Section 3.6.3.2.1.1 (No Action Alternative), any behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Although designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, none of these areas overlap with the use of electromagnetic devices in the Study Area. Therefore, for reasons stated in Section 3.6.3.2.1.1 (No Action Alternative), none of the electromagnetic stressors will affect piping plover critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices during training activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 1, electromagnetic device use would increase by approximately 30 percent in the Study Area as compared to the No Action Alternative. Testing activities involving electromagnetic devices would continue to occur in the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, specifically within the VACAPES Range Complex and the Naval Surface Warfare Center, Panama City Division Testing Range. In addition, activities will be introduced in the South Florida Ocean Measurement Facility Testing Range (Southeast U.S. Continental Shelf Large Marine Ecosystem), and anywhere within the Gulf of Mexico. Activities involving electromagnetic device use will remain concentrated within the Naval Surface Warfare Center, Panama City Division Testing Range. Bird species that occur in these areas, including all ESA-listed bird species and the ESA-candidate red knot, could be exposed to electromagnetic devices.

The increase in activities in previously identified locations, and introduction of activities in the additional locations as described above, would not measurably increase the probability of birds being exposed to electromagnetic energy as compared to the No Action Alternative. The differences in species overlap and potential impacts of electromagnetic devices on bird groups, ESA-listed species, and the ESA-candidate red knot during training activities would not be discernible from those described for testing activities in Section 3.6.3.2.1.1 (No Action Alternative).

For reasons stated in Section 3.6.3.2.1.1 (No Action Alternative), any behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Although designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, none of these areas overlap with the use of electromagnetic devices in the Study Area. Therefore, for reasons stated in Section 3.6.3.2.1.1 (No Action Alternative), none of the electromagnetic stressors will affect piping plover critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices during testing activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.2.1.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be identical as described in Section 3.6.3.2.1.2 (Alternative 1).

Testing Activities

As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), under Alternative 2, electromagnetic device use would increase by approximately 40 percent in the Study Area as compared to the No Action Alternative, but only increases by approximately 10 percent as compared to Alternative 1. The location of testing activities and species potentially impacted under Alternative 2 are identical to those specified under Alternative 1. Bird species that occur in these areas, including all ESA-listed bird species and the ESA-candidate red knot, could be exposed to electromagnetic devices.

The increase in activities in previously identified locations, and introduction of activities in the additional locations as described above, would not measurably increase the probability of birds being exposed to electromagnetic energy as compared to the No Action Alternative. The differences in species overlap and potential impacts of electromagnetic devices on bird groups, ESA-listed species, and the ESA-candidate red knot during testing activities would not be discernible from those described for training activities in Section 3.6.3.2.1.1 (No Action Alternative).

For reasons stated in Section 3.6.3.2.1.1 (No Action Alternative), any behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Although designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, none of these areas overlap with the use of electromagnetic devices in the Study Area. Therefore, for reasons stated in Section 3.6.3.2.1.1 (No Action Alternative), none of the electromagnetic stressors will affect piping plover critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of electromagnetic devices during testing activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.2.2 Impacts from High Energy Lasers

This section analyzes the potential impacts of high energy lasers on birds. As discussed in Section 3.0.5.3.2.2 (Lasers), high energy laser weapons are designed to disable targets, rendering them immobile. The primary concern is the potential for a bird to be directly struck with the laser beam, which could result in injury or death.

3.6.3.2.2.1 No Action Alternative

Under the No Action Alternative, no high energy laser weapon use is planned during training or testing activities.

3.6.3.2.2.2 Alternatives 1 and 2 (Preferred Alternative)

Training Activities

Under Alternatives 1 and 2, no high energy laser weapon use is planned during training activities.

Testing Activities

Under Alternatives 1 and 2, high energy laser weapons tests are introduced in the Northeast U.S. Continental Shelf Large Marine Ecosystem and Gulf Stream Open Ocean Area, specifically within the VACAPES Range Complex. Only bird species that occur within the VACAPES Range Complex would potentially be exposed to high energy lasers. Bird species that do not occur within the VACAPES Range Complex, including ESA-listed Bermuda petrel, would not be exposed to high energy lasers. Species that do occur within this area could be exposed, including the ESA-listed piping plover, ESA-listed roseate tern, and ESA-candidate red knot.

Before a laser can be fired, the Navy requires as a standard operating procedure that no persons, wildlife, reflective surfaces, or nontarget obstructions are present within the potentially impacted area between the laser and the target. In addition, as a standard operating procedure, aircraft avoid large flocks of birds to minimize the safety risk involved with a potential bird strike. A bird in flight or at long distance might not be detectable, but the likelihood of a bird crossing the laser beam at the instant the laser is fired is extremely remote but possible.

Although designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, none of these areas overlap with the use of high energy lasers in the Study Area. However, the range of both the piping plover and roseate terns occur within this area where high energy laser are tested. While piping plovers do forage in the intertidal portions of the Study Area, these areas do not overlap with any locations where high energy laser devices are used. Therefore, none of these activities will affect piping plover critical habitat.

No long-term or population-level impacts are expected. Birds are not likely to be exposed to high energy lasers based on the: (1) relatively low number of activities, (2) very localized potential impact area of the laser beam, (3) temporary duration of potential impact (seconds), and (4) standard operating procedures that include awareness and caution around any birds potentially in the area.

Pursuant to the ESA, the use of high energy lasers during testing activities as described under Alternatives 1 and 2:

- *will have no effect on the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *will have no effect on the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of high energy lasers during testing activities described under Alternatives 1 and 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.3 Physical Disturbance and Strike Stressors

This section describes the potential impacts to birds by aircraft and aerial target strikes, vessels (disturbance and strike), and military expended material strike. For a list of Navy activities that involve this stressor refer to Section 3.0.5.3.3 (Physical Disturbance and Strike Stressors). Aircraft include fixed-wing and rotary-wing aircraft; vessels include various sizes and classes of ships, submarines, and other boats; towed devices, unmanned surface vehicles, and unmanned underwater vehicles; military expended materials include non-explosive practice munitions, target fragments, parachutes, and other objects.

Physical disturbance and strike risks, primarily from aircraft, have the potential to impact all taxonomic groups found within the Study Area (Table 3.6-2). Impacts of physical disturbance include behavioral responses such as temporary disorientation, change in flight direction, and avoidance response behavior. Physical disturbances (discussed in Section 3.6.3.3.1, Impacts from Aircraft and Aerial Targets) may elicit short-term behavioral or physiological responses such as alert response, startle response, cessation of feeding, fleeing the immediate area, and a temporary increase in heart rate. These disturbances can also result in abnormal behavioral, growth, or reproductive impacts in nesting birds and can cause foraging and nesting birds to flush from or abandon their habitats or nests (Andersen et al. 1989; Komenda-Zehnder et al. 2003). Aircraft strikes often result in bird mortalities or injuries (Dolbeer (2006).

Although birds likely hear and see approaching vessels and aircraft, they cannot avoid all collisions. Nighttime lighting on vessels, specifically high-powered searchlights used for navigation in icy waters off of Greenland, has caused birds to become confused and collide with Navy vessels, cargo vessels, and trawlers (Gehring et al. 2009; Merkel and Johansen 2011; Poot et al. 2008). High-speed collisions with large objects can be fatal to birds. Training and testing activities around concentrated numbers of birds would cause greater disturbance and increase the potential for strikes.

3.6.3.3.1 Impacts from Aircraft and Aerial Targets

Aircraft and aerial target strikes could occur during training and testing activities that use aircraft, particularly in nearshore areas, where birds are more concentrated in the Study Area. Training and testing activities where aircraft are used typically occur further offshore, within the range complexes.

Wildlife aircraft strikes are a serious concern for the Navy because these incidents can result in injury to aircrews as well as damage equipment and injure or kill wildlife (Bies et al. 2006). Since 1981 naval aviators reported 16,550 bird strikes at a cost of $350 million. About 90 percent of wildlife/aircraft collisions involve large birds or large flocks of smaller birds (Federal Aviation Administration 2003), and more than 70 percent involve gulls, waterfowl, or raptors. From 2000 to 2009, the Navy Bird Aircraft Strike Hazard program recorded 5,436 bird strikes with the majority occurring during the fall period from September to November. During the 10-year period, bird strikes were greatest in the year 2007 with 827 strikes, and lowest in the year 2001 with 48. The most strikes (642) occurred at Naval Air Station Corpus Christi (Navy Safety Center 2009). No ESA-listed seabirds have been reported in the aircraft strike database.

Though bird strikes can occur anywhere aircraft are operated, Navy data indicate they occur more often over land, but do occur within the Study Area. Bird strike potential is greatest in foraging or resting areas, in migration corridors, and at low altitudes.

For the majority of fixed-wing activities, flight altitudes would be above 3,000 ft., with the exception of sorties associated with air-to-surface bombing exercises and sonobuoy drops. Typical flight altitudes during air-to-surface bombing exercises are from 500 to 5,000 ft. above ground level. Most fixed-wing aircraft flight hours (greater than 90 percent) occur at distances greater than 12 nm offshore.

Helicopter flights would occur closer to the shoreline where sheltering, roosting, and foraging birds occur. Helicopters can hover and fly low, and would be used to include towed electromagnetic devices as well as for other military activities at sea. This combination would make helicopter bird strikes more likely than for fixed-wing aircraft. Additional details on typical altitudes and characteristics of aircraft used in the Study Area are provided in Section 3.0.5.3.1.7 (Aircraft Overflight Noise) and in Appendix A (Navy Activities Descriptions).

In addition to manned aircraft, aerial targets such as unmanned drones and expendable rocket powered missiles could also incur a bird strike but the probability is low. No data about bird strikes to drones or expendable rocket-powered missiles is available.

Approximately 95 percent of bird flight during migration occurs below 10,000 ft., with the majority below 3,000 ft. (U.S. Geological Survey 2006). Bird and aircraft encounters are more likely to occur during aircraft takeoffs and landings than when the aircraft is engaged in level flight. In a study that examined 38,961 bird and aircraft collisions, Dolbeer (2006) found that the majority (74 percent) of collisions occurred below 500 ft. However, collisions have been recorded at elevations as high as 12,139 ft. (Dove and Goodroe 2008).

In a bird strike study for the U.S. Air Force, vultures were the most hazardous group to aircraft followed by geese, pelicans, and buteo hawks based on the number of bird strikes reported (Zakrajsek and Bissonette 2005). These species groups occur within the Study Area but are generally found in nearshore areas (Mowbray et al. 2002; Shields 2002). The potential for bird strikes to occur in off-shore areas is relatively low because activities are widely dispersed and occur at relatively high altitudes (above 3,000 ft. for fixed-wing aircraft) where seabird occurrences are generally low.

Bird populations may consist of hundreds or thousands of individuals, ranging across a large geographical area. In this context, the loss of a small number of birds due to physical strikes does not constitute a population-level effect. Bird exposure to strike potential would be relatively brief as an aircraft transits the area. Strike potential is further decreased by Navy aircrafts' active avoidance of large flocks of birds.

3.6.3.3.1.1 No Action Alternative

Training Activities

Training activities under the No Action Alternative 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 as described in further detail in Table 2.8-1 in Chapter 2 (Description of Proposed Action and Alternatives) and in Section 3.0.5.3.1.7 (Aircraft Overflight Noise). For detailed descriptions of the types of activities that involve aircraft, see Appendix A (Navy Activities Descriptions).

Some bird strikes and associated bird mortalities or injuries could occur as a result of aircraft and aerial target use in the Study Area under the No Action Alternative; however, population-level impacts to birds would not likely result. ESA-listed and ESA-candidate species could be impacted by aircraft disturbance or strikes while in flight in areas where low altitude operations are taking place. However, no ESA-listed bird strikes have been reported during training activities.

Although piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, it does not overlap with fixed-wing aircraft training which would take place further than 1 nm from shore. While aircraft overflights could occur near piping plover critical habitat, the altitudes of their flight paths would be high enough to not pose a direct strike risk to piping plovers while sheltering, roosting, or feeding. Potential impacts from aircraft and aerial targets would have no effect on the primary constituent elements of critical habitat for the piping plover.

Helicopters can hover and fly low as well as out over the open ocean. The combination of helicopters hovering and flying low over the open ocean could result in possible strikes to a piping plover, roseate tern, red knot, or Bermuda petrel. Any disturbance from the noise produced by the aircraft and helicopter overflights in these locations has been discussed in Section 3.6.3.1.5 (Impacts from Aircraft and Vessel Noise).

Bird exposure to strike potential would be relatively brief as an aircraft quickly passes. Birds actively avoid interaction with aircraft. As a standard operating procedure, aircraft avoid large flocks of birds to minimize the personnel safety risk involved with a potential bird strike. Some bird and aircraft strikes and associated bird mortalities or injuries could occur in the Study Area under the No Action Alternative; however, no long-term or population-level impacts are expected.

Pursuant to the ESA, the use of aircraft and aerial targets during training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of aircraft and aerial targets during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Testing activities under the No Action Alternative 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 as described in further detail in Tables 2.8-2 and 2.8-3 in Chapter 2 (Description of Proposed Action and Alternatives) and in Section 3.0.5.3.1.7 (Aircraft Overflight Noise). For detailed descriptions of the types of activities that involve aircraft, See Appendix A (Navy Activities Descriptions). Some bird strikes and associated bird mortalities or injuries could occur as a result of aircraft and aerial target use in the Study Area under the No Action Alternative; however, population-level impacts to birds would not likely result from aircraft strikes. If in the immediate area where aircraft are operating at low altitudes, ESA-listed and ESA-candidate species could be impacted by aircraft disturbance and strike during migration.

For reasons stated in the training activities discussion in this section, disturbance or strike from aircraft or aerial targets are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Similarly, potential impacts from aircraft and aerial targets will have no effect on the primary constituent elements of critical habitat for piping plover. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of aircraft and aerial targets during testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of aircraft and aerial targets during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.1.2 Alternative 1

Training Activities

Training activities under Alternative 1 include an increase in aircraft flight hours from the No Action Alternative in the same areas. The types of activities, locations, and types of aircraft would not differ from the No Action Alternative.

For reasons stated in Section 3.6.3.3.1.1 (No Action Alternative), disturbance or strike from aircraft or aerial targets are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Similarly, potential impacts from aircraft and aerial targets will have no effect on the primary constituent elements of critical habitat for piping plover (see Section 3.6.3.3.1.1, No Action Alternative). No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of aircraft and aerial targets during training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of aircraft and aerial targets during training activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Testing activities under Alternative 1 include an increase in aircraft flight hours from the No Action Alternative. The types of activities, locations, and types of aircraft would not differ from the No Action Alternative.

For reasons stated in Section 3.6.3.3.1.1 (No Action Alternative), disturbance or strike from aircraft or aerial targets are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Similarly, potential impacts from aircraft and aerial targets will have no effect on the primary constituent elements of critical habitat for piping plover (Section 3.6.3.3.1.1, No Action Alternative). No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of aircraft and aerial targets during testing activities as described in Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of aircraft and aerial targets during testing activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.1.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. The only exception to this is the increase of air combat maneuvers over the Key West Range Complex. Air combat maneuvers involve fixed-wing aircraft operating at altitudes in excess of most resident or migratory birds. Therefore, impacts of these activities would also be identical as described in Section 3.6.3.3.1.1 (No Action Alternative).

Pursuant to the ESA, the use of aircraft and aerial targets during training activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of aircraft and aerial targets during training activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Testing activities under Alternative 2 include an increase in aircraft flight hours from the No Action Alternative. The types of activities, locations, and types of aircraft would not differ from the No Action Alternative.

For reasons stated in Section 3.6.3.3.1.1 (No Action Alternative), disturbance or strike from aircraft or aerial targets are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Similarly, potential impacts from aircraft and aerial targets will have no effect on the primary constituent elements of critical habitat for piping plover (Section 3.6.3.3.1.1, No Action Alternative). No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of aircraft and aerial targets during testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of aircraft and aerial targets during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.2 Impacts from Vessels and In-Water Devices

The majority of the training and testing activities under all the alternatives involve vessels, and a few of the activities involve the use of in-water devices. For a discussion of the types of activities that use vessels and in-water devices, where they are used and how many activities would occur under each alternative, see Sections 3.0.5.3.3.1 (Vessels) and 3.0.5.3.3.2 (In-Water Devices). See Table 3.0-25 for a representative list of Navy vessel types, sizes and speeds; and Table 3.0-37 for the types, sizes, and speeds of Navy in-water devices used in the Study Area.

Direct collisions with most Navy vessels are unlikely but do occur, especially at night. Other impacts would be the visual and behavioral disturbance from a vessel. Birds respond to moving vessels in various ways. Some birds, including certain species of gulls, storm petrels, and albatrosses, commonly follow vessels (Favero et al. 2011; Hyrenbach 2001, 2006); while other species such as frigatebirds and sooty terns seem to avoid vessels (Borberg et al. 2005; Hyrenbach 2006). There could be a slightly increased risk of impacts during the winter, or fall/spring migrations when migratory birds are concentrated in coastal areas. However, despite this concentration, most birds would still be able to avoid collision with a vessel. Vessel movements could elicit short-term behavioral or physiological responses (e.g., alert response, startle response, fleeing the immediate area, temporary increase in heart rate). However, the general health of individual birds would not be compromised.

The possibility of collision with an aircraft carrier or surface combatant vessels (or a vessel's rigging, cables, poles, or masts) could increase at night, especially during inclement weather. Birds can become disoriented at night in the presence of artificial light (Bruderer et al. 1999), and lighting on vessels may attract some birds (Hunter et al. 2006a), increasing the potential for harmful encounters (U.S. Department of the Navy 2007). Lighting on boats and vessels has also contributed to bird fatalities in open-ocean environments when birds are attracted to these lights, usually in inclement weather conditions (Merkel and Johansen 2011). Other harmful seabird-vessel interactions are commonly associated with commercial fishing vessels because seabirds are attracted to concentrated food sources around these vessels (Dietrich and Melvin 2004; Melvin et al. 2011; Melvin and Parrish 2001). However, these concentrated food sources are not associated with Navy vessels.

Navy aircraft carriers, surface combatant vessels, and amphibious warfare ships are minimally lighted for tactical purposes. For vessels of this type there are two white lights that shine forward and one that shines aft; these lights must be visible for at least 6 nm. A single red and a single green light are located on the port and starboard sides of vessels, respectively. These lights are visible for a minimum of 3 nm. Solid white lighting appears more problematic for birds, especially nocturnal migrants (Gehring et al. 2009; Poot et al. 2008).

In addition to vessels, towed devices and unmanned vehicles are also used; however, no documented instances of birds being struck by in-water devices exist. It would be anticipated that most bird species would move away from an unmanned vehicle or a towed device.

The other type of vessel movements in the Study Area with the potential to strike a bird are those used during amphibious landings. These amphibious warfare vessels have the potential to impact shorebirds and seabirds by disturbing or striking individual animals. Amphibious vessel movements could elicit short-term behavioral or physiological responses such as alert response, startle response, cessation of feeding, fleeing the immediate area, nest abandonment, and a temporary increase in heart rate. Amphibious vessels have the potential to disturb nesting or foraging shorebirds such as the ESA-listed piping plover, ESA-listed roseate tern, and the ESA-candidate red knot. The general health of individual birds would not be compromised, unless a direct strike occurred. However, it is highly unlikely that a shorebird/seabird would be struck in this scenario because most foraging shorebirds in the vicinity of the approaching amphibious vessel would likely be dispersed by the sound of its approach before it could come close enough to strike a shorebird/seabird (Section 3.6.3.1.5, Impacts from Aircraft and Vessel Noise).

3.6.3.3.2.1 No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative)

Section 3.0.5.3.3.1 (Vessels) and Section 3.0.5.3.3.2 (In-Water Devices) provide estimates of relative vessel use and location for each of the alternatives. These estimates are based on the number of activities predicted for each alternative. While these estimates provide a prediction of use, actual Navy vessel usage is dependent upon military training requirements, deployment schedules, annual budgets and other unpredictable factors. Training and testing concentrations are most dependent upon locations of Navy shore installations and established training and testing areas. Even with the introduction of the

Undersea Warfare Training Range, these areas have not appreciably changed in the last decade and are not expected to change in the foreseeable future. Under Alternatives 1 and 2, the Study Area would be expanded from the No Action Alternative and the number of events may increase, but the concentration of vessel and in-water device use and the manner in which the Navy trains and tests would remain consistent with the range of variability observed over the last decade. This is partly because multiple activities occur from the same vessel platform. Therefore, the increased number of activities estimated for Alternatives 1 and 2 is not expected to result in an increase in vessel use or transit. 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 strikes are expected to occur is likely to remain consistent with the previous decade or be reduced because of the implementation of mitigation measures as outlined in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). The difference in activities from the No Action Alternative to Alternative 1 and Alternative 2, shown in Table 3.0-36, is not likely to change the probability of a vessel strike in any meaningful way.

Training Activities

As indicated in Sections 3.0.5.3.3.1 (Vessels) and 3.0.5.3.3.2 (In-Water Devices), the majority of the training activities under all alternatives involve vessels, and a few of the activities involve the use of in-water devices. See Table 3.0-25 for a representative list of Navy vessel sizes and speeds, Table 3.0-37 for the types, sizes, and speeds of Navy in-water devices used in the Study Area, and Figure 3.0-20 provides graphics that illustrate the location for each alternative and the relative use of for training. These activities could be widely dispersed throughout the Study Area, but would be more concentrated near naval ports, piers and range areas. Navy training vessel traffic would especially be concentrated near Naval Station Norfolk in Norfolk, Virginia, in the Northeast U.S. Continental Shelf Large Marine Ecosystem and Naval Station Mayport in Jacksonville, Florida in the Southeast U.S. Continental Shelf Large Marine Ecosystem. There is no seasonal differentiation in Navy vessel use.

Large vessel movement primarily occurs within the U.S. Exclusive Economic Zone, with the majority of the traffic flowing in a direct line between Naval Stations Norfolk and Mayport. There would be a higher likelihood of vessel strikes over the continental shelf portions than in the open-ocean portions of the Study Area because of the concentration of vessel movements in those areas. Even in areas of concentrated vessel use, the probability of bird/vessel interaction is low because of the high mobility of birds.

As indicated in Section 3.0.5.3.3.2 (In-Water Devices), training activities involving in-water devices occur in the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems, and the Gulf of Mexico, as well as the Gulf Stream Open Ocean Area, specifically within the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. Use of in-water devices is concentrated within the VACAPES Range Complex. The differences in the number of in-water device activities between alternatives increases by less than 2 percent under Alternative 1 and Alternative 2 compared to the No Action Alternative.

Birds would not be exposed to unmanned underwater vehicles or remotely operated vehicles because they are typically used on the seafloor or in the water column. The other in-water devices used are typically towed by a helicopter. As discussed for electromagnetic devices (Section 3.6.3.2.1, Impacts from Electromagnetic Devices), it is likely that any birds in the vicinity of the approaching helicopter would be dispersed by the sound of the helicopter (Section 3.6.3.1.5, Impacts from Aircraft and Vessel Noise) and move away from the in-water device before any exposure could occur.

Amphibious landings are the primary activity that could potentially impact ESA-listed shorebird species, specifically piping plover, roseate tern, and the ESA-candidate red knot. Up to 46 amphibious landings are planned only at Onslow Beach (Marine Corps Base Camp Lejeune), in the Navy Cherry Point Range Complex. Under Alternative 1 and 2, up to six amphibious landings would occur at Naval Station Mayport, specifically Seminole Beach. The ESA-listed species that would be potentially impacted at this location would be piping plover, roseate tern, and the ESA-candidate red knot.

The locations where amphibious landing activities occur at Onslow Beach and Seminole Beach are not considered optimal habitat for piping plovers (U.S. Fish and Wildlife Service 2009b). Roseate terns and red knots could use these beaches as a resting area and could be found foraging in the waters near the beach. Piping plovers have been documented foraging within the intertidal shoreline at Onslow Beach and Seminole Beach during the winter, spring, and fall migration periods and during the nesting season, although no nests have been found to date (U.S. Fish and Wildlife Service 2009b). While they could be present, it is highly unlikely that a piping plover, roseate tern, or red knot would be struck in this scenario because most foraging or resting shorebirds in the vicinity of the approaching amphibious vessel would likely be dispersed by the sound of its approach before it could come close enough for a collision to take place (Section 3.6.3.1.5, Impacts from Aircraft and Vessel Noise). Therefore, amphibious assault activities would not cause any potential risk to the ESA-listed piping plover or roseate tern, or the ESA-candidate red knot in the Study Area. Furthermore, Naval Station Mayport and Marine Corps Base Camp Lejeune have specific Integrated Natural Resource Management Plans for addressing ESA-listed bird species, and those plans already include project avoidance and minimization actions that reduce threats from military activities to wintering and migrating piping plovers to a minimal level (U.S. Fish and Wildlife Service 2009b).

There is no overlap of vessels and in-water devices with designated critical habitat for piping plover. Additionally no critical habitat is designated at Onslow Beach or Seminole Beach. However, critical habitat does exist on the opposite (north) side of the St. Johns River from Seminole Beach. This area of critical habitat is outside the boundary of the Study Area. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of vessels and in-water devices during training activities as described under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, roseate tern, or piping plover;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of vessels and in-water devices during training activities described under the No Action Alternative, Alternative 1, and Alternative 2 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

As indicated in Sections 3.0.5.3.3.1 (Vessels) and 3.0.5.3.3.2 (In-Water Devices), Navy testing vessel traffic would especially be concentrated near Naval Station Norfolk in Norfolk, Virginia, in the Northeast U.S. Continental Shelf Large Marine Ecosystem and Naval Station Mayport in Jacksonville, Florida, in the Southeast U.S. Continental Shelf Large Marine Ecosystem.

As indicated in Section 3.0.5.3.3.2 (In-Water Devices), testing activities involving in-water devices occur in the Northeast U.S. Continental Shelf Large Marine Ecosystems and the Gulf of Mexico as well as the Gulf Stream Open Ocean Area, specifically within the Northeast, VACAPES, Navy Cherry Point, and JAX Range Complexes; and Naval Undersea Warfare Center Division, Newport Testing Range; Naval Surface Warfare Center, Panama City Division Testing Range; and South Florida Ocean Measurement Facility Testing Range. The differences in the number of in-water device activities between alternatives increases by approximately 80 percent under Alternative 1 and doubles under Alternative 2 compared to the No Action Alternative.

The potential for interaction with vessels is greater in coastal areas, where Navy vessel use is concentrated, compared to pelagic waters. Even in areas of concentrated vessel use, the probability of bird/vessel interaction is low because of the high mobility of birds and their ability to quickly move away from an oncoming vessel.

Flushing of birds is expected to be greatest with fast-moving, agile vessels (as described in Table 3.0-25). Impacts from Navy vessels would be limited to short-term behavioral responses, which are not expected to have long-term effects. While such flushing or other impacts of vessels on individual birds may occur, none of these temporary impacts are expected to have an adverse effect on birds at the population level.

The relatively low vessel density in pelagic waters in the Study Area, as well as the ability of birds to detect and avoid vessels, reduces the probability that vessel strikes would impact seabird populations under the No Action Alternative, Alternative 1, and Alternative 2. The impacts of vessel movements are expected to be short-term, temporary, and localized disturbances of individual birds in the vicinity. If in the immediate area where vessels or in-water devices are operating, ESA-species could be disturbed, but this would not result in adverse impacts.

For reasons stated in Section 3.6.3.3.2.1 (No Action Alternative, Alternative 1, and Alternative 2 [Preferred Alternative]), disturbance or strike from vessels or in-water devices are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Similarly, vessels and in-water devices would not result in impacts to the primary constituent elements of critical habitat for piping plover because there is no overlap of the stressor with designated critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of vessels and in-water devices during testing activities as described under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, roseate tern, or piping plover;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of vessels and in-water devices during testing activities described under the No Action Alternative, Alternative 1, and Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.3 Impacts from Military Expended Materials

This section analyzes the strike potential to birds of the following categories of military expended materials: (1) non-explosive practice munitions, (2) fragments from high-explosive munitions, and (3) expended materials other than munitions, such as sonobuoys, vessel hulks, and expendable targets. For a discussion of the types of activities that use military expended materials, where they are used, and how many activities would occur under each Alternative, see Section 3.0.5.3.3.3 (Military Expended Material Strikes). Note that analysis of all potential impacts (disturbance, strike, ingestion, and entanglement) of military expended materials on critical habitat is included in this section.

Exposure of birds to military expended materials during Navy training and testing activities could result in physical injury or behavioral disturbances to birds in air, at the surface, or underwater during foraging dives. Although a quantitative analysis is not possible due to the absence of bird density information in the Study Area, an assessment of the likelihood of exposure to military expended materials was conducted based on general bird distributions in the Study Area.

The number of large-caliber projectiles and other large munitions (e.g., bombs, rockets, missiles) that would be expended in the Study Area annually, coupled with the often patchy distribution of seabirds (Fauchald et al. 2002; Haney 1986b; Schneider and Duffy 1985), suggests that the likelihood of this type of strike for a seabird would be extremely low. The number of small-caliber projectiles that would be expended annually during gunnery exercises is much higher than the number of large-caliber projectiles. However, the total number of rounds expended is not a good indicator of strike probability during gunnery exercises because multiple rounds are fired at individual targets.

Human activity such as vessel or boat movement, aircraft overflights, and target setting, could cause birds to flee a target area before the onset of firing, thus avoiding harm. If birds were in the target area, they would likely flee the area prior to the release of military expended materials or just after the initial rounds strike the target area. Additionally, the force of military expended material fragments dissipates quickly once the pieces hit the water, so direct strikes on birds foraging below the surface would not be likely. Also, munitions would not be used in shallow/nearshore areas. Individual birds may be impacted, but munitions strikes would likely have no impact on bird populations.

The probability of strike based on the “footprint” analysis included in Tables 3.3-9 through 3.3-13 indicates that even for an extreme case of all small-caliber projectiles expended in a single gunnery box, the likelihood of any of these items striking a bird is extremely low.

3.6.3.3.3.1 No Action Alternative

<u>Training Activities</u>

Tables located in Section 3.0.5.3.3.3 (Military Expended Material Strikes) list the activities that involve military expended materials, most of which are small- and medium-caliber projectiles. The number and location of military expended materials (e.g., bombs, projectiles, missiles, and rockets) are detailed in Tables 3.0-70, 3.0-71, 3.0-72, and 3.0-73. As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under the No Action Alternative, the areas with the greatest number of expended materials are expected to be the Northeast and Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems and the Gulf Stream Open Ocean Area, specifically within the VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes. Activities using military expended materials are concentrated within the VACAPES and JAX Range Complexes. Bird species that occur in these areas, including all ESA-listed and ESA-candidate bird species, could be exposed to military expended materials.

The potential impact of military expended materials on birds in the Study Area is dependent on the ability of birds to detect and avoid foreign objects through their visual and auditory sensory systems and the relatively fast flying speeds and good maneuverability of most bird species. The vast area over which training activities occur combined with the ability of birds to flee disturbance, would make direct strikes unlikely. Individual birds may be affected, but strikes would have no impact on species or populations.

If in the immediate area where military expended materials are present, ESA-listed species could be impacted by military expended material strikes. It is highly unlikely that a bird would be struck by military expended materials because most birds in the vicinity of the approaching aircraft or vessel, from which the military expended materials are released, would likely be dispersed by the sound of its approach before it could come close enough for a collision to take place (Section 3.6.3.1.5, Impacts from Aircraft and Vessel Noise). Therefore, activities that release military expended materials would not cause any potential strike risk to ESA-listed and ESA-candidate birds in the Study Area.

Although designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, none of these areas overlap with the use of military expended materials in the Study Area. Therefore, none of the military expended materials will affect piping plover critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of military expended materials for training activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of military expended materials during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Tables located in Section 3.0.5.3.3.3 (Military Expended Material Strikes) list the activities that involve military expended materials (e.g., bombs, projectiles, missiles, and rockets), most of which are small- and medium-caliber projectiles. The number and location of military expended materials are detailed in Tables 3.0-70, 3.0-71, 3.0-72, and 3.0-73. As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under the No Action Alternative, the areas with the greatest amount of expended materials are expected to be the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems and the Gulf Stream Open Ocean Area, specifically within the Naval Surface Warfare Center, Panama City Division Testing Range and the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. Activities using military expended materials are concentrated within the VACAPES Range Complex. Bird species that occur in these areas, including all ESA-listed and ESA-candidate bird species, could be exposed to military expended materials.

If in the immediate area where military expended materials are present, ESA-listed species could be impacted by military expended material strikes. It is highly unlikely that a bird would be struck by military expended materials because most birds in the vicinity of the approaching aircraft or vessel, from which the military expended materials are released, would likely be dispersed by the sound of the approaching aircraft or vessel before it could come close enough to strike a shorebird (Section 3.6.3.1.5, Impacts from Aircraft and Vessel Noise). Therefore, activities that release military expended materials would not cause any potential strike risk to ESA-listed or ESA-candidate bird species in the Study Area.

For reasons stated in the training activities discussion in this section, any behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Similarly, military expended materials would not result in impacts to critical habitat for piping plover because there is no overlap of the stressor with designated critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of military expended materials for testing activities as described under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), military expended material strikes during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.3.2 Alternative 1

Training Activities

Tables located in Section 3.0.5.3.3.3 (Military Expended Material Strikes) list the activities that involve military expended materials (e.g., bombs, projectiles, missiles, and rockets), most of which are small- and medium-caliber projectiles. The number and location of military expended materials are detailed in Tables 3.0-69, 3.0-70, 3.0-71, 3.0-72, and 3.0-73. As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under Alternative 1, the total amount of military expended materials is more than twice the amount expended in the No Action Alternative. The activities and type of military expended materials under Alternative 1 would be expended in the same geographic locations as the No Action Alternative in addition to Other AFTT Areas outside the range complexes while vessels are in transit. Activities using military expended materials are concentrated within the VACAPES, Navy Cherry Point, and JAX Range Complexes. Bird species that occur in these areas, including all ESA-listed and ESA-candidate bird species, could be exposed to military expended materials.

The differences in species overlap and potential impacts of military expended materials on bird groups, ESA-listed species, and the ESA-candidate red knot during training activities would not be discernible from those described for training activities in Section 3.6.3.3.3.1 (No Action Alternative). For reasons stated in Section 3.6.3.3.3.1 (No Action Alternative), any behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Similarly, military expended materials would not result in impacts to critical habitat for piping plover because there is no overlap of the stressor with designated critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of military expended materials for training activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), military expended material strikes during training activities described under the Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

Tables located in Section 3.0.5.3.3.3 (Military Expended Material Strikes) list the activities that involve military expended materials (e.g., bombs, projectiles, missiles, and rockets), most of which are small- and medium-caliber projectiles. The number and location of military expended materials are detailed in Tables 3.0-69, 3.0-70, 3.0-71, 3.0-72, and 3.0-73. As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under Alternative 1, the total amount of military expended materials is nearly four-times the amount expended in the No Action Alternative. The activities and type of military expended materials under Alternative 1 would be expended in the same geographic locations as the No Action Alternative, with the exception of some activities that could occur throughout the Study Area. Activities using military expended materials are concentrated within the VACAPES Range Complex and Naval Surface Warfare Center, Panama City Division Testing Range. Military expended materials would typically be of the same type listed under the No Action Alternative. Bird species that occur in these areas, including all ESA-listed species, could be exposed to military expended materials.

For reasons stated in Section 3.6.3.3.3.1 (No Action Alternative), any behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Similarly, military expended materials would not result in impacts to the critical habitat for piping plover because there is no overlap of the stressor with designated critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of military expended materials for testing activities as described under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the use of military expended materials during testing activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.3.3.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the No Action Alternative will also be identical as described in Section 3.6.3.3.3.2 (Alternative 1).

Testing Activities

Tables located in Section 3.0.5.3.3.3 (Military Expended Material Strikes) list the activities that involve military expended materials (e.g., bombs, projectiles, missiles, and rockets), most of which are small- and medium-caliber projectiles. The number and location of military expended materials are detailed in Tables 3.0-70, 3.0-71, 3.0-72, and 3.0-73. As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under Alternative 2, the total amount of military expended materials is nearly four-times the amount expended in the No Action Alternative, but only increases by approximately 5 percent as compared to Alternative 1. The activities and type of military expended materials under Alternative 2 would be expended in the same geographic locations as the No Action Alternative, with the exception of some activities that could occur throughout the Study Area. Activities using military expended materials are concentrated within the VACAPES Range Complex and Naval Surface Warfare Center, Panama City Division Testing Range. Military expended materials would typically be of the same type listed under the No Action Alternative. Bird species that occur in these areas, including all ESA-listed and ESA-candidate species, could be exposed to military expended materials.

For reasons stated in Section 3.6.3.3.3.1 (No Action Alternative), any behavioral changes are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. Similarly, military expended materials would not result in impacts to the critical habitat for piping plover because there is no overlap of the stressor with designated critical habitat. No long-term or population-level impacts are expected.

Pursuant to the ESA, the use of military expended materials for testing activities as described under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), military expended material strikes during testing activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.4 Ingestion Stressors

This section analyzes the potential impacts of the various types of expended materials used by Navy during training and testing activities within the Study Area. The activities that expend these items and their general distribution are detailed in Section 3.0.5.3.5 (Ingestion Stressors), and aspects of ingestion stressors that are applicable to marine organisms in general are presented in Section 3.0.5.7.5 (Conceptual Framework for Assessing Effects from Ingestion).

Birds could potentially ingest expended materials used by the Navy during training and testing activities within the Study Area. The Navy expends the following types of materials that could become ingestion stressors for birds during training and testing in the Study Area: chaff and flare endcaps/pistons. Ingestion of expended materials by birds could occur in all large marine ecosystems and open ocean areas and would occur either at the surface or just below the surface portion of the water column, depending on the size and buoyancy of the expended object and the feeding behavior of the birds. Floating material of ingestible size could be eaten by birds that feed at or near the water surface, while materials that sink pose a potential risk to diving birds that feed just below the water's surface (Titmus and Hyrenbach 2011). Some items, such as parachutes or sonobuoys are too large to be ingested and will not be discussed further. Also, parachutes sink rapidly to the seafloor.

Foraging depths of most diving birds are generally restricted to shallow depths, so it is highly unlikely that benthic, nearshore, or intertidal foraging would occur in areas of munitions use, and these birds would not encounter any type of munitions or fragments from munitions in nearshore or intertidal areas. Ingestion of military expended materials from munitions is not expected to occur because the solid metal and heavy plastic objects from these munitions sink rapidly to the seafloor, beyond the foraging depth range of most birds. Therefore, the impact of ingestion of munitions used during training and testing activities for all Alternatives will have no effect on ESA-listed or ESA-candidate birds. As a result, the analysis in this section includes the potential ingestion of military expended materials other than munitions, all of which are expended away from nearshore habitats and close to the water surface.

Physiological impacts to birds from ingestion include blocked digestive tracts and subsequent food passage, blockage of digestive enzymes, lowered steroid hormone levels, delayed ovulation (egg maturation), reproductive failure, nutrient dilution (nonnutritive debris displaces nutritious food in the gut), and altered appetite satiation (the sensation of feeling full), which can lead to starvation (Azzarello and Van Vleet 1987). While ingestion of marine debris has been linked to bird mortalities, sublethal impacts are more common (Moser and Lee 1992).

Many species of seabirds are known to ingest floating plastic debris and other foreign matter while feeding on the surface of the ocean (Auman et al. 1997; Yamashita et al. 2011). For example, 21 of 38 seabird species (55 percent) collected off the coast of North Carolina from 1975 to 1989 had ingested plastic particles (Moser and Lee 1992). Some seabirds have used plastic and other marine debris for nest building which may lead to ingestion of that debris (Votier et al. 2011).

Plastic is often mistaken for prey, and the incidence of plastic ingestion appears to be related to a bird's feeding mode and diet (Henry et al. 2011). Seabirds that feed by pursuit-diving, surface-seizing, and dipping tend to ingest plastic, while those that feed by plunging or piracy typically do not ingest plastic (Azzarello and Van Vleet 1987). Birds of the order Procellariiformes, which include petrels and shearwaters, tend to accumulate more plastic than other species (Azzarello and Van Vleet 1987; Moser and Lee 1992; Pierce et al. 2004). Some birds, including gulls and terns, commonly regurgitate indigestible parts of their food items such as shell and fish bones. However, the structure of the digestive systems of most Procellariiformes makes it difficult to regurgitate solid material such as plastic (Azzarello and Van Vleet 1987; Moser and Lee 1992; Pierce et al. 2004).

Moser and Lee (1992) found no evidence that seabird health was impacted by the presence of plastic, but other studies have documented negative consequences of plastic ingestion (Carey 2011). As summarized by Pierce et al. (2004), Auman et al. (1997), and Azzarello and Van Vleet (1987), the consequences of plastic ingestion by seabirds that have been documented include blockage of the intestines and ulceration of the stomach, reduction in the functional volume of the gizzard leading to a reduction of digestive capability, and distention of the gizzard leading to a reduction in hunger.

Dehydration has also been documented in seabirds that have ingested plastic (Sievert and Sileo 1993). Studies have also found negative correlations between body weight and plastic load, as well as between body fat (a measure of energy reserves), and the number of pieces of plastic in a seabird's stomach. Pierce et al. (2004) described two cases where plastic ingestion caused seabird mortality from starvation. The examination of a deceased adult northern gannet revealed that a 1.5 in. (3.8 cm) diameter plastic bottle cap lodged in its gizzard blocked the passage of food into the small intestine, which resulted in its death from starvation. Northern gannets are substantially larger, and dive deeper than the ESA-listed birds in the Study Area. Also, since gannets typically utilize flotsam in nest building (Votier et al. 2011), they may be more susceptible to ingesting marine debris than other species as it gathers that material. Dissection of an adult greater shearwater’s gizzard revealed that a 1.5 in. by 0.5 in. (3.8 cm by 1.3 cm) fragment of plastic blocked the passage of food in the digestive system, which also resulted in death from starvation.

Species such as storm-petrels, albatrosses, shearwaters, fulmars, and noddies that forage by picking prey from the surface may have a greater potential to ingest any floating plastic debris. Although ingestion of plastic military expended materials by any species from the 10 taxonomic groups found within the Study Area (Table 3.6-2) has the potential to impact individual birds.

Items of concern are those of ingestible size that remain floating at the surface, including lighter items such as plastic end caps from chaff and flares, pistons, and chaff, that may be caught in currents and gyres or snared in floating *Sargassum* before sinking.

Chaff. A general discussion of chaff and chaff end caps as an ingestion stressor is presented in Section 3.0.5.3.5.3 (Military Expended Materials Other than Munitions). It is unlikely that chaff would be selectively ingested (U.S. Department of the Air Force 1997). Ingestion of chaff fibers is not expected to cause substantial damage to a bird’s digestive tract based on the fibers’ small size (ranging in lengths of 0.25–3 in. [0.63–7.6 cm] with a diameter of about 0.0015 in.) and flexible nature, as well as the small quantity that could reasonably be ingested. In addition, concentrations of chaff fibers that could reasonably be ingested are not expected to be toxic to birds. Scheuhammer (1987) reviewed the metabolism and toxicology of aluminum in birds and mammals. Intestinal adsorption of orally ingested aluminum salts was very poor, and the small amount adsorbed was almost completely removed from the body by excretion. Dietary aluminum normally has minor impacts on healthy birds and mammals, and often high concentrations (greater than 1,000 milligrams [mg] per kg) are needed to induce effects such as impaired bone development, reduced growth, and anemia (Spargo 1999). A bird weighing 2.2 lb. (1 kg) would need to ingest more than 83,000 chaff fibers per day to receive a daily aluminum dose equal to 1,000 mg per kg; this analysis was based on chaff consisting of 40 percent aluminum by weight and a 5 oz. (ounces) (141.7 g) chaff canister containing 5 million fibers. As an example, an adult herring gull weighs about 1.8–2.7 lb. (0.8–1.2 kg) (Cornell Lab of Ornithology 2009b). It is highly unlikely that a bird would ingest a toxic dose of chaff based on the anticipated environmental concentration of chaff (i.e., 1.8 fibers per $ft.^2$ for an unrealistic, worst-case scenario of 360 chaff cartridges simultaneously released at a single drop point).

Flares. A general discussion of flares as an ingestion stressor is presented in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions). Ingestion of flare end caps 1.3 in. (3.3 cm) in diameter and 0.13 in. (0.33 cm) thick (U.S. Department of the Air Force 1997) by birds may result in gastrointestinal obstruction or reproductive complications. Based on the information presented above, if a seabird were to ingest a plastic end-cap or piston, the response would vary based on the species and individual bird. The responses could range from none, to sublethal (reduced energy reserves), to lethal (digestive tract blockage leading to starvation). Ingestion of end caps and pistons by species that regularly regurgitate indigestible items would likely have no adverse impacts. However, end caps and pistons are similar in size to those plastic pieces described above that caused digestive tract blockages and eventual starvation. Therefore, ingestion of plastic end caps and pistons could be lethal to some individual seabirds. Species with small gizzards and anatomical constrictions that make it difficult to regurgitate solid material would likely be most susceptible to blockage (such as Procellariiformes). Based on available information, it is not possible to accurately estimate actual ingestion rates or responses of individual birds.

3.6.3.4.1.1 No Action Alternative

Training Activities

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under the No Action Alternative, activities involving target materials use would occur in the Northeast and Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream and North Atlantic Gyre Open Ocean Areas, specifically within the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes.

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials other than Munitions), under the No Action Alternative, activities involving chaff and flare use would occur in the Northeast and Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area, specifically within the VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes.

Although these fibers are too small for birds to confuse with prey, there is some potential for chaff to be incidentally ingested along with other prey items. If ingested, chaff is not expected to impact birds, due to the low concentration that would be ingested and the small size of the fibers.

The plastic materials associated with flare end caps and pistons sink in saltwater (Spargo 1999), which reduces the likelihood of ingestion by seabirds. However, some of the material could remain at or near the surface if it were to fall directly on a dense *Sargassum* mat. As discussed in Section 3.0.5.3.5.3 (Military Expended Materials other than Munitions), the highest density of chaff and flare end caps/pistons would be expended in the Key West Range Complex. Assuming that all end caps and pistons would be evenly dispersed in the Key West Range Complex, the relative end-cap and piston concentration would be very low (2.8 pieces/nm^2/year, based on an area of 25,500 nm^2 and 71,885 end caps/pistons per year). Actual environmental concentrations would vary based on actual release points and dispersion by wind and water currents. The number of end caps and pistons that would remain at the surface in *Sargassum* mats, and would potentially be available to seabirds, is expected to be an extremely small percentage of the total.

Birds could ingest military expended material. However, the concentration of military expended materials in the Study Area is low, and seabirds are unevenly distributed (Fauchald et al. 2002; Haney 1986b; Schneider and Duffy 1985). The overall likelihood that birds would be impacted by ingestion of military expended materials in the Study Area under the No Action Alternative is very low. If foraging in an area where military expended materials are present on the sea surface, roseate terns and Bermuda petrels could be impacted by ingestion of military expended material, but this would not result in impacts on populations of these ESA-listed species. Species that forage outside the specified areas within these range complexes, including the piping plover and red knot, would not be exposed to the ingestible military expended materials. No long-term or population-level impacts are expected.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions for training activities as proposed under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, or roseate tern;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials (including munitions) during training activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

Testing Activities

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under the No Action Alternative, activities involving target materials use would occur in the Northeast and Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream and North Atlantic Gyre Open Ocean Areas, specifically within the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. In addition, activities that expend target materials would occur at Naval Surface Warfare Center, Panama City Division Testing Range.

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under the No Action Alternative, activities involving chaff and flare use would occur in the Northeast and Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems as well as the Gulf Stream Open Ocean Area, specifically within the VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes.

The plastic materials associated with end caps and pistons sink in saltwater (Spargo 1999), which reduces the likelihood of ingestion by seabirds. However, some of the material could remain at or near the surface if it were to fall directly on a dense *Sargassum* mat. Actual environmental concentrations would vary based on actual release points and dispersion by wind and water currents. The number of end caps and pistons that would remain at the surface in *Sargassum* mats and would potentially be available to seabirds is expected to be an extremely small percentage of the total.

If foraging in an area where military expended materials are present on the sea surface, roseate terns and Bermuda petrels could be impacted by ingestion of military expended material, but this would not result in impacts on populations of these ESA-listed species. Species occurring outside the specified areas within these range complexes, including the piping plover and red knot, would not be exposed to the ingestible military expended materials.

For reasons stated in Section 3.6.3.4.1.1 (No Action Alternative), any ingestion of military expended materials is not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. No long-term or population-level impacts are expected.

Pursuant to the ESA, the potential for ingestion of military expended materials for testing activities as proposed under the No Action Alternative:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, or roseate tern;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials (including munitions) during testing activities described under the No Action Alternative would not result in a significant adverse effect on migratory bird populations.

3.6.3.4.1.2 Alternative 1

Training Activities

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under Alternative 1, the number of activities that expend target-related materials is four-times that of the No Action Alternative. In addition to the geographic locations identified in the No Action Alternative, target-related materials would also be expended in the Key West Range Complex as well as anywhere in the Study Area, outside the range complexes while vessels are in transit.

As indicated in Sections 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under Alternative 1, the number of activities that expend chaff decreases by approximately 30 percent from the No Action Alternative, while flares increase by approximately 30 percent. The activities using chaff under Alternative 1 would occur in the same geographic locations as the No Action Alternative.

If foraging in an area where military expended materials are present on the sea surface, roseate terns and Bermuda petrels could be impacted by ingestion of military expended material, but this would not result in impacts on populations of these ESA-listed species. Species occurring outside the specified areas within these range complexes, including the piping plover and red knot, would not be exposed to the ingestible military expended materials.

For reasons stated in Section 3.6.3.4.1.1 (No Action Alternative), any ingestion of military expended materials is not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. No long-term or population-level impacts are expected.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions for training activities as proposed under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, or roseate tern;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials (including munitions) during training activities described under the Alternative 1 would not result in a significant adverse effect on migratory bird populations.

Testing Activities

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under Alternative 1, the number of activities that expend target-related materials of ingestible size is approximately two-times that of the No Action Alternative. In addition to the geographic locations identified in the No Action Alternative, target-related materials would also be expended in the Key West Range Complex and Gulf of Mexico. In addition, there are testing activities that could expend target-related materials throughout the Study Area.

As indicated in Sections 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under Alternative 1, the number of activities that expend chaff and flares is approximately four-times and three-times greater, respectively, compared to the No Action Alternative. The activities using chaff and flares under Alternative 1 would occur in the same geographic locations as the No Action Alternative.

If foraging in an area where military expended materials are present on the sea surface, roseate terns and Bermuda petrels could be impacted by ingestion of military expended material, but this would not result in impacts on populations of these ESA-listed species. Species occurring outside the specified areas within these range complexes, including the piping plover and red knot, would not be exposed to the ingestible military expended materials.

For reasons stated in Section 3.6.3.4.1.1 (No Action Alternative), any ingestion of military expended materials is not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. No long-term or population-level impacts are expected.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions for testing activities as proposed under Alternative 1:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, or roseate tern;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials (including munitions) during testing activities described under Alternative 1 would not result in a significant adverse effect on migratory bird populations.

3.6.3.4.1.3 Alternative 2 (Preferred Alternative)

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, impacts and comparisons to the Section 3.6.3.4.1.1 (No Action Alternative) will also be identical as described in Section 3.6.3.4.1.2 (Alternative 1).

Testing Activities

As indicated in Section 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under Alternative 2 the activities will occur in the same geographic locations identified in the No Action Alternative. The number of activities that expend target-related materials is more than 2.5-times that of the No Action Alternative, but only increases by approximately 10 percent from Alternative 1. In addition, target-related materials would also be expended in the Key West Range Complex, Gulf of Mexico, and throughout the Study Area.

As indicated in Sections 3.0.5.3.5.3 (Military Expended Materials Other Than Munitions), under Alternative 2, the number of activities that expend chaff is nearly four-times that of the No Action Alternative, but only increases by approximately 10 percent from Alternative 1. Under Alternative 2, the number of activities that expend flares is nearly three-times that of the No Action Alternative, but only increases by approximately 10 percent from Alternative 1. The activities using chaff and flares under Alternative 2 would occur in the same geographic locations as the Section 3.6.3.4.1.1 (No Action Alternative).

If foraging in an area where military expended materials are present on the sea surface, roseate tern and Bermuda petrel could be impacted by ingestion of military expended material, but this would not result in increased risk of impacts on populations of these ESA-listed species. Species occurring outside the specified areas within these range complexes, including the piping plover and red knot, would not be exposed to the ingestible military expended materials.

For reasons stated in Section 3.6.3.4.1.1 (No Action Alternative), any ingestion of military expended materials is not expected to have lasting effects on the survival, growth, recruitment, or reproduction of bird populations. No long-term or population-level impacts are expected.

Pursuant to the ESA, the potential for ingestion of military expended materials other than munitions for testing activities as proposed under Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, or roseate tern;*
- *will have no effect on the ESA-listed piping plover; and*
- *will have no effect on the ESA-candidate red knot.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from ingestion of military expended materials (including munitions) during testing activities described under Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.3.5 Secondary Stressors

The potential of water and air quality stressors associated with training and testing activities to indirectly affect birds, as a secondary stressor, was analyzed. The assessment of potential water and air quality stressors refers to Section 3.1 (Sediments and Water Quality) and Section 3.2 (Air Quality); the assessment addresses specific activities in local environments that have the potential to impact seabird habitats. At-sea activities that may impact water and air include general emissions.

As noted in Section 3.1 (Sediments and Water Quality) and Section 3.2 (Air Quality), implementation of the No Action Alternative, Alternative 1, or Alternative 2 would not adversely affect sediments, water, or air quality, and therefore would not indirectly impact seabirds as secondary stressors. Any physical impacts on seabird habitats (sediments, water, or air quality) would be temporary and localized. These activities would not be expected to indirectly impact birds or bird habitats.

As noted in Section 3.8 (Marine Invertebrates) and Section 3.9 (Fish), implementation of the No Action Alternative, Alternative 1, or Alternative 2 would not adversely impact invertebrate or fish prey resources (e.g., crustaceans, bivalves, worms, sand lance, herring, etc.) of birds and therefore would not indirectly impact birds as secondary stressors. Any impacts on seabird prey resources would be temporary and localized. These activities would not be expected to indirectly impact birds or bird habitats.

Although designated piping plover critical habitat occurs throughout the coastal habitats of the Southeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, none of these areas overlap activities that could potentially impact sediments, water, or air quality. Two of the primary constituent elements of critical habitat required by piping plover (i.e., sheltering and roosting) are applicable only to their terrestrial beach habitats, which are outside of the Study Area. The other primary constituent element is foraging. While piping plovers do forage in the intertidal portions of the Study Area, these areas do not overlap with any locations where military activities occur that have any potential to impact sediments, water, or air quality. Therefore, secondary stressors will not affect piping plover critical habitat. Indirect impacts on sediments, water, or air quality under the No Action Alternative, Alternative 1, or Alternative 2 would not affect ESA-listed bird species or ESA-candidate red knot due to: (1) the temporary nature of impacts on sediments, water, or air quality, (2) the distribution of temporary sediments, water, or air quality impacts, (3) the wide distribution of birds in the Study Area, and (4) the dispersed spatial and temporal nature of the training and testing activities that may have temporary sediments, water, or air quality impacts. No long-term or population-level impacts are expected.

3.6.3.5.1 No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative) – Training and Testing

Pursuant to the ESA, secondary stressors for training and testing activities as proposed under the No Action Alternative, Alternative 1, and Alternative 2:

- *may affect but is not likely to adversely affect the ESA-listed Bermuda petrel, piping plover, or roseate tern;*
- *may affect but is not likely to adversely affect the ESA-candidate red knot; and*
- *will have no effect on piping plover critical habitat.*

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the impacts from secondary stressors during training and testing activities described under the No Action Alternative, Alternative 1, or Alternative 2 would not result in a significant adverse effect on migratory bird populations.

3.6.4 Summary of Potential Impacts on Birds

3.6.4.1 Combined Impacts of All Stressors

As described in Section 3.0.5 (Overall Approach to Analysis), 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 the analyses of each stressor in the sections above and summarized in Section 3.6.4.2 (Endangered Species Act Determinations).

There are generally two ways that a bird could be exposed to multiple stressors. The first would be if a bird were exposed to multiple sources of stress from a single activity or activities (e.g., an amphibious landing activity may include an amphibious vessel that would introduce potential acoustic and physical strike stressors). The potential for a combination of these impacts from a single activity would depend on the range of effects to each of the stressors and the response or lack of response to that stressor. Most of the activities as described in the Proposed Action involve multiple stressors; therefore, it is likely that if a bird were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously. This would be more likely to occur during large-scale exercises or activities that span a period of days or weeks (such as a sinking exercise or composite training unit exercise).

Secondly, an individual bird could be exposed to a combination of stressors from multiple activities over the course of its life. This is most likely to occur in areas where training and testing activities are more concentrated (e.g., near ports, testing ranges, and routine activity locations outlined in Table 3.0-8) and in areas that individual birds frequent because it is within the animal's home range, migratory route, breeding area, or foraging area. With the exception of the few concentrated areas mentioned above, combinations are unlikely to occur because training and testing activities are generally separated in space and time in such a way that it would be very unlikely that any individual birds would be exposed to stressors from multiple activities. However, animals with a small home range intersecting an area of concentrated Navy activity have elevated exposure risks relative to animals that simply transit the area via a migratory route. The majority of the proposed training and testing activities occur over a small spatial scale relative to the entire Study Area, have few participants, and are of a short duration (on the order of a few hours or less).

Multiple stressors may also have synergistic effects. For example, birds 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. Birds that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to 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 on birds are difficult to predict.

Although potential impacts to certain bird species from the Proposed Action could include injury or mortality, impacts are not expected to decrease the overall fitness or result in long-term population-level impacts of any given population. In cases where potential impacts rise to the level that warrants mitigation, mitigation measures designed to reduce the potential impacts are discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). The potential impacts anticipated from the Proposed Action are summarized in Sections 3.6.4.2 (Endangered Species Act Determinations) and 3.6.4.3 (Migratory Bird Treaty Act Determinations) with respect to each regulation applicable to birds.

3.6.4.2 Endangered Species Act Determinations

Table 3.6-5 summarizes the ESA determinations for each substressor analyzed. Pursuant to the ESA, the Navy has undertaken Section 7 consultation with U.S. Fish and Wildlife Service for the proposed and ongoing activities in the AFTT Study Area under Alternative 2 (Preferred Alternative). For all substressors, training and testing activities are not likely to destroy or modify piping plover critical habitat. The consultation is complete and U.S. Fish and Wildlife Service concurred with the Navy’s determinations.

3.6.4.3 Migratory Bird Treaty Act Determinations

Under the Migratory Bird Treaty Act regulations applicable to military readiness activities (50 C.F.R. Part 21), the stressors introduced during training and testing activities would not result in a significant adverse effect on migratory bird populations.

Table 3.6-5: Summary of Endangered Species Act Effects Determinations for Birds for Alternative 2 (Preferred Alternative)

Navy Activities and Stressors		Bermuda petrel	Piping plover	Roseate tern	Red knot
Acoustic Stressors					
Sonar and other Active Acoustic Sources	Training Activities	No effect	No effect	May affect not likely to adversely affect	No effect
	Testing Activities	No effect	No effect	May affect not likely to adversely affect	No effect
Explosives	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
Swimmer Defense Airguns	Training Activities	Not applicable	Not applicable	Not applicable	Not applicable
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
Pile Driving	Training Activities	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect	No effect
	Testing Activities	Not applicable	Not applicable	Not applicable	Not applicable
Weapons Firing, Launch, and Impact Noise	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	May affect not likely to adversely affect
Aircraft and Vessel Noise	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
Energy Stressors					
Electromagnetic Devices	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
High Energy Lasers	Training Activities	Not applicable	Not applicable	Not applicable	Not applicable
	Testing Activities	No effect	No effect	No effect	No effect

Table 3.6-5: Summary of Endangered Species Act Effects Determinations for Birds for Alternative 2 (Preferred Alternative) (Continued)

Navy Activities and Stressors		Bermuda petrel	Piping plover	Roseate tern	Red knot
Physical Disturbance and Strike Stressors					
Aircraft and Aerial Targets	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
Vessels and In-Water Devices	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
Military Expended Materials	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
Ingestion Stressors					
Military Expended Materials Other than Munitions	Training Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
	Testing Activities	May affect not likely to adversely affect	No effect	May affect not likely to adversely affect	No effect
Secondary Stressors					
Secondary Stressors	Training Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect
	Testing Activities	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect	May affect not likely to adversely affect

Note: The scientific names of the listed species are as follows: Bermuda petrel (*Pterodroma cahow*), piping plover (*Charadrius melodus*), roseate tern (*Sterna dougallii*), and red knot (*Calidris canutus rufa)*.

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