The Mariana Islands Training and Testing

Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS)
United States Department of the Navy

Vol. 2

September 2013 | Draft EIS/OEIS

Mariana Islands
Training and Testing Activities
Draft Environmental Impact Statement/
Overseas Environmental Impact Statement

Volume 2

September
2013

MITT EIS/OEIS Project Manager
Naval Facilities Engineering Command, Pacific
258 Makalapa Dr., Ste 100
Pearl Harbor, HI 96860-3134

3.8 Marine Invertebrates

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

3.8 Marine Invertebrates

MARINE INVERTEBRATES SYNOPSIS

The United States Department of the Navy considered all potential stressors, and the following have been analyzed for marine invertebrates:

- Acoustic (sonar and other active acoustic sources; underwater explosives; swimmer defense airguns; weapons firing, launch and impact noise; aircraft noise; and vessel noise)
- Energy (electromagnetic)
- Physical disturbance or strikes (vessels, in-water devices, military expended materials, and seafloor devices)
- Entanglement (fiber optic cables and guidance wires, and parachutes)
- Ingestion (military expended materials)
- Secondary

Preferred Alternative (Alternative 1)

- Acoustics: Pursuant to the Endangered Species Act (ESA), the use of sonar and other active acoustic sources; underwater explosives; swimmer defense airguns; weapons firing, launch and impact noise; aircraft noise; and vessel noise may affect but is not likely to adversely affect coral species currently proposed for ESA listing as threatened or endangered.
- Energy: Pursuant to the ESA, the use of electromagnetic devices would have no effect on coral species currently proposed for ESA listing as threatened or endangered.
- Physical Disturbance and Strike: Pursuant to the ESA, the use of vessels, in-water devices, and military expended materials may affect, but is not likely to adversely affect, coral species currently proposed for ESA listing as threatened or endangered. The use of seafloor devices would have no effect on coral species currently proposed for ESA listing as threatened or endangered.
- Entanglement: Pursuant to the ESA, the use of fiber optic cables and guidance wires as well as parachutes/decelerators would have no effect on coral species currently proposed for ESA listing as threatened or endangered.
- Ingestion: Pursuant to the ESA, the use of military expended materials would have no effect on coral species currently proposed for ESA listing as threatened or endangered.
- Secondary: Pursuant to the ESA, secondary stressors would have no effect on coral species currently proposed for ESA listing as threatened or endangered.
- There is no marine invertebrate critical habitat in the Study Area.
- Pursuant to the Essential Fish Habitat (EFH) requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of sonar and other acoustic sources, vessel noise, swimmer defense airguns, weapons firing noise, electromagnetic sources, vessel movement, in-water devices, and metal, chemical, or other material contaminants will have no adverse effect on sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern. The use of electromagnetic sources will have minimal and temporary adverse impact to invertebrates occupying water column EFH or Habitat Areas of Particular Concern. The use of explosives, military expended materials, seafloor devices, and explosives and explosive byproduct contaminants may have an adverse effect on EFH by reducing the quality and quantity of sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern.

3.8.1 INTRODUCTION

In this Environmental Impact Statement (EIS)/Overseas EIS (OEIS), marine invertebrates are evaluated based on their distribution and life history relative to the stressor or activity being considered. Activities are analyzed for their potential impact on marine invertebrates in general, on taxonomic groupings of marine invertebrates as appropriate, and on species listed under the Endangered Species Act (ESA) in the Mariana Islands Training and Testing (MITT) Study Area.

Invertebrates are animals without backbones, and marine invertebrates are a large and diverse group. Many of these species are important to humans ecologically and economically, providing essential ecosystem services (coastal protection) and income from commercial and recreational fisheries (Spalding et al. 2001). Because marine invertebrates occur in all habitats, activities that interact with the water column or the seafloor could impact countless zooplankton (e.g., copepods, fish eggs, larvae, and jellyfish), larger invertebrates living in water column (e.g., squid), and benthic invertebrates that live on or in the seafloor (e.g., clams, crabs).

The following subsections provide brief introductions to major taxonomic groups and federally listed species of marine invertebrates that occur in the Study Area. Profiles of these species, along with major taxonomic groups in the Study Area (as defined in Paulay 2003a), are described in this section. The National Oceanic and Atmospheric Administration Office of Protected Resources maintains a website that provides additional information on the biology, life history, species distribution (including maps), and conservation of listed, proposed, or candidate invertebrate species.

Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act will be described in the Essential Fish Habitat Assessment (EFHA), and conclusions from the EFHA will be summarized in each substressor section.

3.8.1.1 Endangered Species Act – Listed Species

In response to a petition from the Center for Biological Diversity to list under the ESA and designate critical habitat for species of coral, National Marine Fisheries Service (NMFS) reviewed the status of 82 "candidate species" of corals. Candidate species are those petitioned species that are actively being considered for listing as endangered or threatened under the ESA, as well as those species for which NMFS has initiated an ESA status review that it has announced in the Federal Register (FR). In April 2012, NMFS completed a status review report and draft Management Report of the candidate species of corals.

Fifty-two species of coral found in the Study Area were potential candidates for listing under the ESA (National Oceanic and Atmospheric Administration 2010a; National Oceanic and Atmospheric Administration and U.S. Department of Commerce 2010). The presence or possible presence of these species in the Study Area has been noted by Randall (2003), Center for Biological Diversity (2009), and the International Union for Conservation of Nature.

On 7 December 2012, the NMFS published a proposed rule with the determination that 66 of these 82 species warrant listing under the ESA as either threatened or endangered. Of these 66 species, 40 potentially occur within the Study Area (Table 3.8-1) based on their life histories (Brainard et al. 2011).

Table 3.8-1: Species Proposed for Endangered Species Act Listing within the Mariana Islands Training and Testing Study Area

Species Names				
Family	**Common Name**	**Scientific Name**	**Threatened/ Endangered**	**Abundance[3]**
Acroporidae	Bottlebrush Staghorn	*Acropora aculeus*[1,2]	Threatened	Common
	Fuzzy Table Coral	*Acropora paniculata*[2]	Threatened	Rare
	Blue-Tipped Staghorn	*Acropora acuminata*[1,2]	Threatened	Uncommon
	Staghorn Coral	*Acropora aspera*[1,2]	Threatened	Common
		Acropora globiceps[2]	Threatened	Common
		Acropora listeri[2]	Threatened	Uncommon
		Acropora microclados	Threatened	Uncommon
		Acropora palmerae[1,2]	Threatened	Uncommon
		Acropora polystoma	Threatened	Uncommon
		Acropora striata[1,2]	Threatened	Rare
		Acropora tenella[2]	Threatened	Common
		Acropora vaughani[1,2]	Threatened	Uncommon
		Acropora verweyi[1,2]	Threatened	Common/Locally abundant
	Staghorn Coral	*Anacropora puertogalerae*[2]	Threatened	Uncommon
		Anacropora spinosa[2]	Endangered	Uncommon
		Isopora cuneata[1,2]	Threatened	Common
	Pore Coral	*Montipora caliculata*[1,2]	Threatened	Uncommon
		Montipora lobulata[1,2]	Threatened	Rare
	Ringed Rice Coral	*Montipora patula*	Threatened	Rare
Agaracidae	Leaf Coral	*Pavona diffluens*[1,2]	Threatened	Uncommon
	Rugosa Coral	*Pachyseris rugosa*[2]	Threatened	Common
Euphyllidae	Grape Coral	*Euphyllia cristata*[1,2]	Threatened	Uncommon
		Euphylla paraancora[2]	Threatened	Uncommon
		Physogyra lichtensteini[2]	Threatened	Common
Faviidae	Faviid Coral	*Barabattoia laddi*[2]	Threatened	Rare
Milliporidae	Fire Coral	*Millepora foveolata*[1]	Endangered	Rare
		Millepora tuberosa[1,2]	Threatened	Rare
Mussidae	Starry Cup Coral	*Acanthastrea brevis*[2]	Threatened	Uncommon
		Acanthastrea ishigakiensis[2]	Threatened	Uncommon
		Acanthastrea regularis[2]	Threatened	Uncommon
Pectinidae	Lettuce Coral	*Pectinia alcicornis*[2]	Threatened	Uncommon
Pocilliporidae	Cauliflower Coral	*Pocillopora danae*[1]	Threatened	Uncommon
		Pocillopora elegans[1,2]	Threatened	Common
	Bird Nest Coral	*Seriatopora aculeata*[1,2]	Threatened	Uncommon

Table 3.8-1: Species Proposed for Endangered Species Act Listing within the Mariana Islands Training and Testing Study Area (continued)

Species Names				
Family	**Common Name**	**Scientific Name**	**Threatened/ Endangered**	**Abundance[3]**
Portidae	Net Coral	*Alveopora allingi*[1,2]	Threatened	Uncommon
		Alveopora fenestrate[1,2]	Threatened	Uncommon
		Alveopora verrilliana[1,2]	Threatened	Uncommon
	Hump Coral	*Porites horizontalata*[1,2]	Threatened	Common
		Porites napopora[1,2]	Threatened	Common
		Porites nigrescens[2]	Threatened	Common

[1] Randall 2003
[2] Center for Biological Diversity 2009
[3] Brainard et al. 2011

3.8.1.2 Taxonomic Groups

All marine invertebrate species groups are represented in the Study Area. Paulay (2003a) presents an overview of the marine biodiversity of Guam, which has the best documented marine biota in Micronesia. Of all the species noted in the marine biodiversity survey of Guam (which included chordates, protists [mostly unicellular organisms], and algae species), it was found that seven major invertebrate species groups (Table 3.8-2) comprise approximately 65 percent of the species observed (Paulay 2003a) (Figure 3.8-1). Throughout the marine invertebrate section, organisms will often be referred to by their phylum name, or more generally, as marine invertebrates.

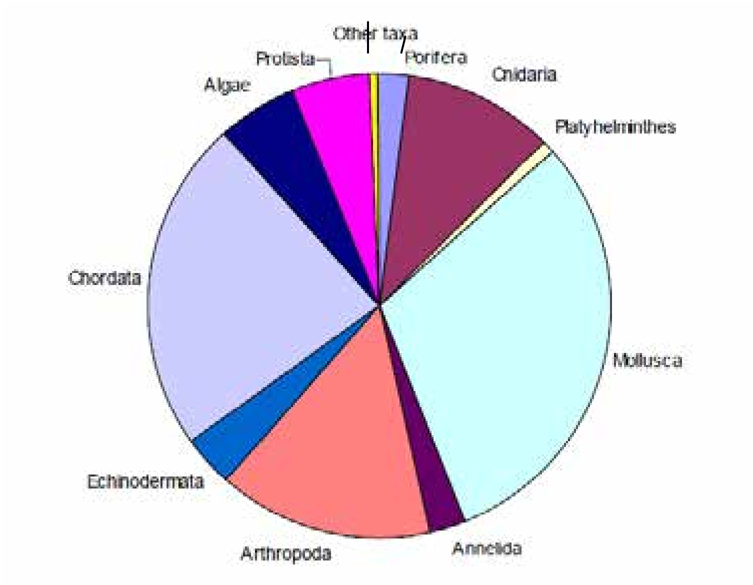
Table 3.8-2: Major Taxonomic Groups of Marine Invertebrates in the Mariana Islands Training and Testing Study Area

Major Invertebrate Groups[1]		Presence in Study Area	
Common Name (Phylum)	**Description**	**Open Ocean**	**Coastal Waters**
Cephalopods, bivalves, sea snails, chitons (Mollusca)	Benthic and planktonic predators, filter feeders, and grazers, with a muscular foot and in some groups a ribbon-like band of teeth used to scrape food off rocks	Water column, seafloor	Water column, seafloor
Shrimp, crabs, lobsters, barnacles, copepods (Arthropoda Subphylum Crustacea)	Benthic and planktonic predators, filter feeders with segmented bodies and external skeletons with jointed appendages	Water column, seafloor	Water column, seafloor
Corals, hydroids, jellyfish (Cnidaria)	Benthic and planktonic animals with stinging cells; sessile corals are main builders of coral reef frameworks	Water column, seafloor	Water column, seafloor
Sea stars, sea urchins, sea cucumbers (Echinodermata)	Benthic predators, filter feeders with tube feet	Seafloor	Seafloor

Table 3.8-2: Major Taxonomic Groups of Marine Invertebrates in the Mariana Islands Training and Testing Study Area (continued)

Other Invertebrate Groups[2]		Presence in Study Area	
Common Name (Phylum)	Description	Open Ocean	Coastal Waters
Segmented worms (Annelida)	Mostly benthic, highly mobile marine worms, many tube-dwelling species	Seafloor	Seafloor
Sponges (Porifera)	Benthic animals; sessile filter feeders, large species have calcium carbonate or silica spicules or bodies embedded in cells to provide structural support	Seafloor	Seafloor
Flatworms (Platyhelminthes)	Mostly benthic, simplest form of marine worm with a flattened body	Water column, seafloor	Water column, seafloor
Ribbon worms (Nemertea)	Benthic marine worms with long extension (proboscis) from the mouth that helps capture food	Water column, seafloor	Seafloor
Round worms (Nematoda)	Small benthic marine worms, many live in close association with other animals (parasitic)	Water column, seafloor	Water column, seafloor
Foraminifera, radiolarians, ciliates (Kingdom Protozoa)	Benthic and planktonic single-celled organisms; shells typically made of calcium carbonate or silica	Water column, seafloor	Water column, seafloor

[1] Major invertebrate groups are based on Marine Diversity of Guam (Paulay 2003a) and Catalogue of Life (Bisby et al. 2010).
[2] Other invertebrate groups are represented in the "Other Taxa" category of Paulay (2003a).
Notes: Benthic = A bottom-dwelling organism, Planktonic = An organism (or life stage of an organism) that drifts in open ocean environments.



Source: Paulay 2003a

Figure 3.8-1: Diversity of Phylogenetic Groups in the Mariana Islands

3.8.2 Affected Environment

Marine invertebrates live in the world's oceans, from warm-shallow waters to cold-deep waters. They inhabit the seafloor and water column in all of the large marine ecosystems and open-ocean areas in the Study Area. Marine invertebrate distribution in the Study Area is influenced by habitat, ocean currents, physical and water chemistry factors such as temperature, salinity and nutrient content (Levinton 2009). The distribution of invertebrates is also influenced by their distance from the equator (latitude); in general, the number of marine invertebrate species increases toward the equator (Macpherson 2002). The higher number of species (diversity) and abundance of marine invertebrates in coastal habitats, compared with the open ocean, is a result of the food and protection that coastal habitats provide (Levinton 2009).

The Mariana nearshore environment is characterized by extensive coral bottom and coral reef areas. There are fewer reef-building hard coral species and genera in the northern compared to the southern Mariana Islands: 159 species and 43 genera of hard coral species in the northern islands versus 256 species and 56 genera in the southern islands (Randall 2003; Abraham et al. 2004). There is also a greater species diversity of fishes and molluscs (invertebrates) in waters around the southern islands than around the northern islands. For example, Guam has diverse invertebrate assemblages, known species include 59 flatworms, 1,722 molluscs, 104 polychaetes, 840 arthropods, and 196 echinoderm species (Abraham et al. 2004; Burdick et al. 2008).

In general, the coral reefs of the Marianas have a lower coral diversity compared to other reefs in the northwestern Pacific (e.g., Palau, Philippines, Australian Great Barrier Reef, southern Japan, and Marshall Islands) but a higher diversity than the reefs of Hawaii. Corals reported in Guam are typically found on shallow reefs and upper forereefs (or outer portion of the reef, closest to open ocean) at depths less than 245 feet (ft.) (74.7 meters [m]), and deeper forereef habitats within the photic zone that allows for coral growth (greater than 245 ft. [greater than 74.7 m] water depth) (Randall 2003).

On the island of Guam, most northern shorelines are karstic (layer or layers of soluble bedrock, usually carbonate rock such as limestone or dolomite) and bordered by limestone cliffs. In a few areas, the shorelines consist of volcanic substrates. On windward shores, reefs are narrow and have steep forereefs. Narrow reef flats or shallow fringing reefs (approximately 325 to 3,250 ft. [99.06 to 990.6 m] wide) are characteristic of leeward and more protected coastlines. Reefs also occur in lagoonal habitats in Apra Harbor and Cocos Lagoon. Reef organisms also occur on eroded limestone substrates including submerged caves and crevices, and large limestone blocks fallen from shoreline cliffs (Paulay 2003b).

3.8.2.1 Invertebrate Hearing and Vocalization

Very little is known about sound detection and use of sound by aquatic invertebrates (Budelmann 2010; Montgomery et al. 2006; Popper et al. 2001). Organisms may detect sound by sensing either the particle motion or pressure component of sound, or both. Aquatic invertebrates probably do not detect pressure since many are generally the same density as water and few, if any, have air cavities that would function like the fish swim bladder in responding to pressure (Budelmann 2010; Popper et al. 2001). Many aquatic invertebrates, however, have ciliated "hair" cells that may be sensitive to water movements, such as those caused by currents or water particle motion very close to a sound source (Budelmann 2010; Mackie and Singla 2003). These cilia may allow invertebrates to sense nearby prey or predators or help with local navigation.

Aquatic invertebrates that can sense local water movements with ciliated cells include cnidarians, flatworms, segmented worms, urochordates (tunicates), molluscs, and arthropods (Budelmann 2010;

Popper et al. 2001). The sensory capabilities of corals are largely limited to detecting water movement using receptors on their tentacles (Gochfeld 2004), and the exterior cilia of coral larvae likely help them detect nearby water movements (Vermeij et al. 2010). Some aquatic invertebrates have specialized organs called statocysts for the determination of equilibrium and, in some cases, linear or angular acceleration. Statocysts allow an animal to sense movement, and may enable some species, such as cephalopods and crustaceans, to be sensitive to water particle movements associated with sound (Hu et al. 2009; Kaifu et al. 2008; Montgomery et al. 2006; Popper et al. 2001). Because any acoustic sensory capabilities, if present at all, are limited to detecting water motion, and water particle motion near a sound source falls off rapidly with distance, aquatic invertebrates are probably limited to detecting nearby sound sources rather than sound caused by pressure waves from distant sources.

Both behavioral and auditory brainstem response studies suggest that crustaceans may sense sounds up to 3 kilohertz (kHz), but best sensitivity is likely below 200 Hertz (Hz) (Lovell et al. 2005; Lovell et al. 2006). Most cephalopods (e.g., octopus and squid) likely sense low-frequency sound below 1,000 Hz, with best sensitivities at lower frequencies (Budelmann 2010; Mooney et al. 2010; Packard et al. 1990). A few cephalopods may sense higher frequencies up to 1,500 Hz (Hu et al. 2009). Squid did not respond to toothed whale ultrasonic echolocation clicks at peak sound pressure levels ranging from 199 to 226 decibels (dB) referenced to (re) 1 micropascal (µPa), likely because these clicks were outside of squid hearing range (Wilson et al. 2007). However, squid exhibited alarm responses when exposed to broadband sound from an approaching seismic airgun with received levels exceeding 145 to 150 dB re 1 micropascal squared second (μPa^2-s) root mean square (McCauley et al. 2000b). Four species of cephalopods showed damage to statocysts following exposure to a swept sine waveform (50 to 400 Hz) repeated every second for 2 hours with a peak of 175 dB re 1 µPa (Andre et al. 2011).

Aquatic invertebrates may produce and use sound in territorial behavior, to deter predators, to find a mate, and to pursue courtship (Popper et al. 2001). Some crustaceans, such as lobsters and snapping shrimp, produce sound by rubbing or closing hard body parts together (Latha et al. 2005; Patek and Caldwell 2006). The snapping shrimp chorus makes up a significant portion of the ambient noise budget in many locales (Cato and Bell 1992). Each click is up to 215 dB re 1 µPa, with a peak around 2 to 5 kHz (Heberholz and Schmitz 2001). Other crustaceans make low-frequency rasping or rumbling noises, perhaps used in defense or territorial display, that are often obscured by ambient noise (Patek and Caldwell 2006; Patek et al. 2009).

Reef noises, such as fish pops and grunts, sea urchin and parrotfish grazing (around 1.0 kHz to 1.2 kHz), and snapping shrimp noises (around 5 kHz) (Radford et al. 2010), may be used as a cue by some aquatic invertebrates. Nearby reef noises were observed to affect movements and settlement behavior of coral and crab larvae (Jeffs et al. 2003; Radford et al. 2007; Stanley et al. 2010; Vermeij et al. 2010). Larvae of other crustacean species, including pelagic and nocturnally emergent species that benefit from avoiding coral reef predators, appear to avoid reef noises (Simpson et al. 2011). Detection of reef noises is likely limited to short distances (less than 330 ft. [100 m]) (Vermeij et al. 2010).

3.8.2.2 General Threats

The health and abundance of marine invertebrates are vital to the marine ecosystem and the sustainability of the world's fisheries (Pauly et al. 2002). Coral reefs can be stressed or damaged by coastal development (Risk 2009), impacts from inland pollution and erosion (Cortes and Risk 1985), overexploitation and destructive fishing practices (Jackson et al. 2001, Pandolfi et al. 2003), global climate change and acidification (Hughes et al. 2003), disease (Porter et al. 2001), predation, harvesting by the aquarium trade (Caribbean Fishery Management Council 1994), anchors (Burke and Maidens

2004), invasive species (Bryant et al. 1998; Galloway et al. 2009, National Marine Fisheries Service 2010b; Wilkinson 2002), ship groundings (National Oceanic and Atmospheric Administration 2010b), oil spills (National Oceanic and Atmospheric Administration 2001), and possibly human-made noise (Brainard et al. 2011, Vermeij et al. 2010).

The reefs near populated areas Guam, Saipan, Tinian, and Rota receive most of the human impacts from coastal development, population growth, fishing, and tourism. These threats can result in coral death from coastal runoff (Downs et al. 2009), reduced growth rates caused by a decrease in the pH of the ocean from pollution (Cohen et al. 2009), reduced tolerance to global climate change (Carilli et al. 2010), and increased susceptibility to bleaching (which are often tied to atypically high sea temperatures [Brown 1997; Glynn 1993; van Oppen and Lough 2009]). Human-made noise may impact coral larvae by masking the natural sounds that serve as cues to orient them towards suitable settlement sites (Vermeij et al. 2010).

Exposure to runoff from land from development projects can also affect local reef communities. Erosion rates in the Ugum Watershed on Guam doubled from 1975 to 1993 as a result of road construction and development projects. The discharge of cleaning chemicals has also occurred, with subsequent impacts on local coral populations (Wilkinson 2002). Exposure to oil runoff from land, and natural seepage is another threat to marine invertebrates. Additional information on the biology, life history, and conservation of marine invertebrates (ESA-listed species, species of concern, and candidate species) can be found on the website maintained by the National Marine Fisheries Service.

The discussion above represents general threats to marine invertebrates. Additional threats to individual species within the Study Area are described below in the accounts of those species. The following sections include descriptions of species listed or proposed to be listed as threatened or endangered under the ESA, and descriptions of the major marine invertebrate taxonomic groups in the Study Area. The species-specific information emphasizes the ESA-listed and candidate species because any threats to or potential impacts on those species are subject to consultation with regulatory agencies.

The ESA process for the 66 species of reef-building corals proposed for listing (originally petitioned by the Center for Biological Diversity [Sakashita and Wolf 2009]) is the broadest and most complex listing process undertaken by NMFS (Brainard et al. 2011). A rigorous threat evaluation was developed for these corals, and 19 key threats were selected as the most important factors influencing the potential extinction of candidate coral species before the year 2100 (Table 3.8-3). Because most of these threats are also known to generally affect marine invertebrate groups, the information is presented here in General Threats rather than within a subsequent subsection.

Table 3.8-3: Summary of Proximate Threats to Coral Species

Proximate Threat[1]	Importance	Used in Coral ESA Determinations
Ocean Warming	High	Yes
Disease	High	Yes
Ocean Acidification	Med-High	Yes
Reef Fishing – Trophic Effects	Medium	Yes
Sedimentation	Low-Medium	Yes
Nutrients	Low-Medium	Yes
Sea-Level Rise	Low-Medium	Yes
Toxins	Low	No
Changing Ocean Circulation	Low	No
Changing Storm Tracks/Intensities	Low	No
Predation	Low	Yes
Reef Fishing – Habitat Impacts/Destructive Fishing Practices	Low	No
Ornamental Trade	Low	Yes
Natural Physical Damage	Low	No
Human-induced Physical Damage	Negligible-Low	No
Aquatic Invasive Species	Negligible-Low	No
Salinity	Negligible	No
African/Asian Dust	Negligible	No
Changes in Insolation	Probably Negligible	No

[1] As summarized by Brainard et al. (2011). The authors note that, accepting “natural physical damage” and “changes in insolation,” the ultimate factor for all of the proximate threats is growth in human population and consumption of natural resources.

Note: ESA = Endangered Species Act

3.8.2.3 *Acropora aculeus* (Bottlebrush coral)

3.8.2.3.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for bottlebrush coral (*Acropora aculeus*) as threatened (77 FR 73220–73262). The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012). NMFS has not proposed a critical habitat designation for the bottlebrush coral.

3.8.2.3.2 Habitat and Geographic Range

Acroporid corals (the largest group of stony corals) are typically found in shallow, warm, nutrient-poor waters that allow sufficient sunlight penetration to support photosynthesis by zooxanthellae, single-cell algae hosted by the coral. Throughout its range, Acroporid corals can be found on any stretch of reef and is often the dominant coral, especially along the reef front. Staghorn and plate forms flourish in sheltered areas, whereas clusters and semi-massive types can withstand more exposed conditions.

Acropora aculeus has a broad depth range. It is particularly abundant in shallow lagoons and is common in most habitats where it is protected from direct wave action. *Acropora aculeus* has been reported in water depths ranging from low tide to at least 20 m (65.6 ft.) (Brainard et al. 2011).

Acropora aculeus has a relatively broad range, extending from east Africa, the Comorros, and Seychelles in the Indian Ocean all the way to Pitcairn Island in the southeastern Pacific Ocean. Latitudinally, it has been reported from Japanese waters in the northern hemisphere across the southern Great Barrier Reef and Mozambique in the southern hemisphere. According to both the International Union for Conservation of Nature and Natural Resources Species Account and the Convention on International Trade in Endangered Species species database, *Acropora aculeus* occurs in American Samoa, the Northern Mariana Islands, and the United States (U.S.) minor outlying islands (Brainard et al. 2011).

3.8.2.3.3 Population and Abundance

Abundance of *Acropora aculeus* has been reported as generally common and locally abundant, especially in the central Indo-Pacific (Veron 2000).

3.8.2.3.4 Predator-Prey Interactions

Most species from the Acroporidae family are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) and by corallivorous snails.

3.8.2.3.5 Species-Specific Threats

Bottlebrush coral has no species-specific threats. It is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population’s demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Acropora aculeus* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized range-wide abundance, wide overall distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.4 *Acropora paniculata* (Fuzzy Table coral)

3.8.2.4.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for fuzzy table coral (*Acropora paniculata*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports. Additional information regarding this coral species, including the Petition to List 82Coral Species Under the ESA by the Center for Biological Diversity (Sakashita and Wolf 2009), can be accessed at the website maintained by the NMFS Office of Protected Resources. Critical habitat has not yet been proposed for this species.

3.8.2.4.2 Habitat and Geographic Range

Acropora paniculata has been reported to occupy upper reef slopes, just subtidal, reef edges, and sheltered lagoons in water depths ranging from 10 to 35 m (32.8 to 114.8 ft.) (Brainard et al. 2011).

Acropora paniculata has been reported across a wide distribution ranging from the Red Sea and Indian Ocean to the west and central Pacific.

3.8.2.4.3 Population and Abundance

Abundance of *Acropora paniculata* has been reported as uncommon to rare on most reefs; however, the fuzzy table coral is common in Papua New Guinea.

3.8.2.4.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Acropora paniculata*. Most species from the Acroporidae family are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) and by corallivorous snails.

3.8.2.4.5 Species-Specific Threats

Acroporia paniculata is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. paniculata* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, wide overall distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.5 *Acropora acuminata* (Blue-Tipped Staghorn coral)

3.8.2.5.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for blue-tipped staghorn coral (*Acropora acuminata*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.5.2 Habitat and Geographic Range

Acropora acuminata has a very broad range, extending longitudinally from the Red Sea all the way to Pitcairn Island in the southeastern Pacific. It extends latitudinally from Taiwan in the northern hemisphere across the Great Barrier Reef in the southern hemisphere. It can be very common in the center of its range (e.g., Indonesia), but it can be uncommon in the outer parts of its range. Throughout its range, Acroporid corals can be found on any stretch of reef and is often the dominant coral, especially along the reef front where it has been reported in waters ranging from 15 to 20 m (49.2 to 65.6 ft.). Staghorn and plate forms flourish in sheltered areas, whereas clusters and semi-massive types can withstand more exposed conditions.

3.8.2.5.3 Population and Abundance

Acropora acuminata has been reported to occasionally live in extensive clumps with dimensions of several meters.

3.8.2.5.4 Predator-Prey Interactions

Acropora acuminata is the only acroporid known to not be preferred as prey by the crown-of-thorns seastar. The crown-of-thorns seastar will eat *A. acuminata* if there are no other corals to prey on, but *A. acuminata are* among the last to be preyed upon.

3.8.2.5.5 Species-Specific Threats

Acroporia acuminata is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. acuminata* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, wide overall distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.6 *Acropora aspera* (Staghorn coral)

3.8.2.6.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the staghorn coral (*Acropora aspera*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.6.2 Habitat and Geographic Range

Acropora aspera has been reported to occupy a broad range of habitats and its colony structure varies substantially with habitat and has been reported in water depths ranging from low tide to at least 10 m (32.8 ft.).

Acropora aspera has a relatively broad range, extending longitudinally from the Red Sea and Oman to Samoa (east central Pacific Ocean). It extends latitudinally from Japanese waters in the northern hemisphere across the Great Barrier Reef in the southern hemisphere. According to both the International Union for Conservation of Nature and Natural Resources Species Account and the Convention on International Trade in Endangered Species of Wild Fauna and Flora species database, *Acropora aspera* occurs in American Samoa, the Northern Mariana Islands, and the U.S. minor outlying islands.

3.8.2.6.3 Population and Abundance

Abundance of *Acropora aspera* has been reported as sometimes locally common. *Acropora aspera* can occasionally live in extensive clumps with dimensions of several meters.

3.8.2.6.4 Predator-Prey Interactions

Most Acropora are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) and by corallivorous snails. *Acropora aspera* is a preferred prey of *Acanthaster planci* and, when killed, is rapidly overgrown by algae.

3.8.2.6.5 Species-Specific Threats

Acroporia aspera is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. aspera* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, narrow overall distribution (based on moderate geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.7 *Acropora globiceps* (Staghorn coral)

3.8.2.7.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the staghorn coral (*Acropora globiceps*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.7.2 Habitat and Geographic Range

Acropora globiceps has been reported from the central Indo-Pacific, the oceanic west Pacific, and the central Pacific (Richards et al. 2008a). It has been reported as common and relatively widespread longitudinally but restricted latitudinally and has a narrow depth range. *Acropora globiceps* has been reported from intertidal, upper reef slopes, and reef flats (Veron 2000) and has been reported in water depths ranging from 0 to 8 m (0 to 26.2 ft.).

3.8.2.7.3 Population and Abundance

Within its range, *Acropora globiceps* has been reported as common.

3.8.2.7.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Acropora globiceps*. However, most acroporid corals are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) and by corallivorous snails.

3.8.2.7.5 Species-Specific Threats

Acroporia globiceps is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. globiceps* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, narrow overall distribution (based on moderate geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.8 *Acropora listeri* (Staghorn coral)

3.8.2.8.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the staghorn coral (*Acropora listeri*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.8.2 Habitat and Geographic Range

Acropora listeri has been reported from the Red Sea, the northern Indian Ocean, the central Indo-Pacific, east and west coasts of Australia, Southeast Asia, Japan and the East China Sea, the oceanic west Pacific, and the central Pacific (Richards et al. 2008b). *A. listeri* has been reported from subtidal shallow reef edges, upper reef slopes, and in strong wave action in water depths ranging from near the surface to 15 m (49.2 ft.).

3.8.2.8.3 Population and Abundance

Abundance of *Acropora listeri* has been reported as uncommon.

3.8.2.8.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Acropora listeri*. However, most acroporid corals are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci)* and by corallivorous snails.

3.8.2.8.5 Species-Specific Threats

Acroporia listeri is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. listeri* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, overall moderate distribution (based on wide geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.9 *Acropora microclados (*Staghorn coral)

3.8.2.9.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the staghorn coral (*Acropora microclados*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.9.2 Habitat and Geographic Range

Acropora microclados has been reported from the Red Sea and the Gulf of Aden, the northern Indian Ocean, the central Indo-Pacific, Australia, Southeast Asia, Japan and the East China Sea, and the oceanic west Pacific (Richards et al. 2008c). *A. microclados* has been reported from upper reef slopes and subtidally at reef edges in water depths ranging from 5 to 20 m (16.4 to 65.6 ft.).

3.8.2.9.3 Population and Abundance

Abundance of *Acropora microclados* has been reported as uncommon.

3.8.2.9.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Acropora microclados*. However, most acroporid corals are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci)* and by corallivorous snails.

3.8.2.9.5 Species-Specific Threats

Acroporia microclados is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. microclados* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, wide overall distribution (based on wide geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.10 *Acropora palmerae* (Staghorn coral)

3.8.2.10.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the staghorn coral (*Acropora palmerae*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.10.2 Habitat and Geographic Range

Acropora palmerae has been reported from the northern Indian Ocean, central Indo-Pacific, west and east coasts of Australia, Southeast Asia, Japan and the East China Sea, and the oceanic west Pacific.

Acropora palmerae has been reported to occupy reef flats exposed to strong wave action and lagoons and intertidal, subtidal, shallow, reef tops, reef flats, and reef edges in water depths ranging from 5 to 20 m (16.4 to 65.6 ft.).

3.8.2.10.3 Population and Abundance

Abundance of *Acropora palmerae* has been reported as uncommon.

3.8.2.10.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Acropora palmerae*. However, most acroporid corals are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) and by corallivorous snails.

3.8.2.10.5 Species-Specific Threats

Acroporia palmerae is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population’s demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. palmerae* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, moderate overall distribution (based on moderate geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.11 *Acropora polystoma* (Staghorn coral)

3.8.2.11.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the staghorn coral (*Acropora polystoma*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.11.2 Habitat and Geographic Range

Acropora polystoma has been reported from the Red Sea and the Gulf of Aden, the south-west and northern Indian Ocean, the central Indo-Pacific, Australia, Southeast Asia, and the oceanic west Pacific (Richards et al. 2008d). *A. polystoma* has been reported from shallow, tropical reef environments. It is found on upper reef slopes exposed to strong wave action in water depths ranging from 3 to 10 m (9.8 to 32.8 ft.).

3.8.2.11.3 Population and Abundance

Abundance of *Acropora polystoma* has been reported as uncommon.

3.8.2.11.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Acropora polystoma*. However, most acroporid corals are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci)* and by corallivorous snails.

3.8.2.11.5 Species-Specific Threats

Acroporia polystoma is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. polystoma* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, moderate overall distribution (based on wide geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.12 *Acropora striata* (Staghorn coral)

3.8.2.12.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the staghorn coral (*Acropora striata*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.12.2 Habitat and Geographic Range

Acropora striata has been reported to have a moderately broad range overall. A search of published and unpublished records of occurrence in U.S. waters indicates *Acropora striata* has been reported from Ofu Lagoon in American Samoa, Guam (Randall 2003), Commonwealth of the Northern Mariana Islands, and Kingman Reef.

Acropora striata has been reported to occupy shallow rocky foreshores and shallow reef in water depths ranging from 10 to 25 m (32.8 to 82.0 ft.).

3.8.2.12.3 Population and Abundance

Abundance of *Acropora striata* has been reported as rare overall but may be locally dominant in some areas in Japan.

3.8.2.12.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Acropora striata*. Most Acropora are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) and by corallivorous snails.

3.8.2.12.5 Species-Specific Threats

Acroporia striata is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. striata* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, moderate overall distribution (based on moderate geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.13 *Acropora tenella* (Staghorn coral)

3.8.2.13.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the staghorn coral (*Acropora tenella*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.13.2 Habitat and Geographic Range

Acropora tenella has been reported to have a moderately broad range overall, from the central Indo-Pacific, Japan, the East China Sea, and Southeast Asia, and includes the Mariana Islands (Aeby et al. 2008).

Acropora tenella has been reported to occupy lower slopes below 40 m (131.2 ft.), protected slopes and shelves as deep as 70 m (229.7 ft.), apparently specialized to calm, deep conditions in water depths ranging from 25 to 70 m (82.0 to 229.7 ft.). *Acropora tenella* is known primarily from mesophotic habitats, suggesting the potential for deep refugia.

3.8.2.13.3 Population and Abundance

Abundance of *Acropora tenella* has been reported as locally common in some locations.

3.8.2.13.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Acropora tenella*. Most Acropora are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) and by corallivorous snails.

3.8.2.13.5 Species-Specific Threats

Acroporia tenella is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. tenella* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, wide overall distribution (based on moderate geographic distribution and wide depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.14 *Acropora vaughani* (Staghorn coral)

3.8.2.14.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the staghorn coral (*Acropora vaughani*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.14.2 Habitat and Geographic Range

Reported ranges of *Acropora vaughani* have been somewhat disjunct, with reports from Australia, the Red Sea, and southwest Indian Ocean. *Acropora v*aughani occurs in American Samoa and U.S. minor outlying islands, and also in the Northern Mariana Islands (Richards et al. 2008e).

Acropora vaughani has been reported to occupy fringing reefs with turbid water, protected lagoons and sandy slopes, or protected subtidal waters in water depths ranging from low tide levels to 30 m (98.4 ft.).

3.8.2.14.3 Population and Abundance

Abundance of *Acropora vaughani* has been reported as uncommon.

3.8.2.14.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Acropora vaughani*. Most Acropora are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci*) and by corallivorous snails.

3.8.2.14.5 Species-Specific Threats

Acroporia vaughani is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. vaughani* proposed threatened status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, moderate overall distribution (based on wide geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.15 *Acropora verweyi* (Staghorn coral)

3.8.2.15.1 Status and Management

As In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the staghorn coral (*Acropora verweyi*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.15.2 Habitat and Geographic Range

Acropora verweyi has been reported to have a relatively broad range, extending from east Africa, the Comorros and Seychelles in the Indian Ocean all the way to Pitcairn Island in the southeastern Pacific Ocean which includes American Samoa and the Northern Mariana Islands (Richards et al. 2008f).

Acropora verweyi lives on upper reef slopes or other parts of the reef where circulation is good and has been reported to be an exclusively shallow-water species (Wallace 1999), living in depths ranging from low tide to at least 10 m (32.8 ft.).

3.8.2.15.3 Population and Abundance

Abundance of *Acropora verweyi* has been reported as generally common but can be locally abundant, especially in the western Indian Ocean.

3.8.2.15.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Acropora verweyi*. Most Acropora are preferentially consumed by crown-of-thorns seastars (*Acanthaster planci)* and by corallivorous snails.

3.8.2.15.5 Species-Specific Threats

Acroporia verweyi is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Acropora verweyi*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification; common generalized rangewide abundance, moderate overall distribution (based on wide geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.16 *Anacropora puertogalerae* (Staghorn coral)

3.8.2.16.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the staghorn coral (*Anacropora puertogalerae*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.16.2 Habitat and Geographic Range

Anacropora puertogalerae has been reported throughout the Indo-Pacific, on the Great Barrier Reef in Australia, Fiji, Indonesia, Japan, and other areas. *Anacropora puertogalerae* has been reported to occur in the Northern Mariana Islands (Richards et al. 2008g).

Anacropora puertogalerae has been reported to occupy shallow reef environments in water depths ranging from 5 to 20 m (16.4 to 65.6 ft.), though it has also been found separated from reefs.

3.8.2.16.3 Population and Abundance

Abundance of *Anacropora puertogalerae* has been reported as uncommon but can form large thickets in the Philippines.

3.8.2.16.4 Predator-Prey Interactions

Anacropora puertogalerae have been reported to be preyed on by wrasses, in proportion to availability. However, population-level effects remain unknown.

3.8.2.16.5 Species-Specific Threats

Anacroporia puertogalerae is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to A*. puertogalerae's* status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, moderate overall distribution (based on moderate geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.17 *Anacropora spinosa* (Staghorn coral)

3.8.2.17.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the staghorn coral (*Anacropora spinosa*) as endangered (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.17.2 Habitat and Geographic Range

Anacropora spinosa has been reported primarily in the Indo-Pacific, in Indonesia, Japan, and the Philippines. The Convention on International Trade in Endangered Species of Wild Fauna and Flora database does not list *Anacropora spinosa* in U.S. waters, although the International Union for Conservation of Nature and Natural Resources Species Account lists it in the Northern Marianas.

Anacropora spinosa has been reported to occupy shallow reef environments, generally in clear or slightly turbid water and on soft substrates of lower reef slopes in water depths ranging from 5 to 15 m (16.4 to 49.2 ft.). *Anacropora spinosa* has also been found separated from reefs.

3.8.2.17.3 Population and Abundance

Abundance of *Anacropora spinosa* has been reported as uncommon, but it may occur in extensive tracts in certain areas.

3.8.2.17.4 Predator-Prey Interactions

Anacropora spinosa have been reported to be preyed on by wrasses, in proportion to availability. However, population-level effects remain unknown.

3.8.2.17.5 Species-Specific Threats

Anacroporia spinosa is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *A. spinosa*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, narrow overall distribution (based on narrow geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.18 *Isopora cuneata* (Staghorn coral)

3.8.2.18.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the staghorn coral (*Isopora cuneata*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.18.2 Habitat and Geographic Range

The International Union for Conservation of Nature and Natural Resources and Veron (2000) consider *Isopora cuneata* to be found from the coast of eastern Africa to the central Pacific. According to both the International Union for Conservation of Nature and Natural Resources Species Account and the Convention on International Trade in Endangered Species of Wild Fauna and Flora species database, *Isopora cuneata* occurs in American Samoa and the Northern Mariana Islands. This database also lists it for the U.S. minor outlying islands.

Isopora cuneata is found most commonly in shallow, high-wave energy environments. Although it is occasionally found on sheltered reef slopes and backreef lagoons, it is more typical of reef crests and inner reef flats in water depths ranging from low tide to 15 m (49.2 ft.).

3.8.2.18.3 Population and Abundance

Abundance of *Isopora cuneata* has been reported as generally common and occasionally locally abundant (Veron 2000).

3.8.2.18.4 Predator-Prey Interactions

Susceptibility of the family Acroporidae to predation stems from reports that most Acropora spp. have been preferentially consumed by crown-of-thorns seastars. In addition, Acropora spp. have been reported to be favored prey of the gastropods Drupella spp. and other corallivorous snails.

3.8.2.18.5 Species-Specific Threats

Isopora cuneata is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *I. cuneata*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, moderate overall distribution (based on moderate geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.19 *Montipora caliculata* (Pore coral)

3.8.2.19.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the pore coral (*Montipora caliculata*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.19.2 Habitat and Geographic Range

Montipora caliculata has a wide distribution from western Sumatra through the Pitcairn Islands. It also has fairly wide latitudinal range from Taiwan to mid-Australia. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Montipora caliculata* occurs in American Samoa, Northern Mariana Islands, and also the U.S. minor outlying islands (DeVantier et al. 2008a).

Montipora caliculata are found in most reef environments at depths of up to 20 m (65.6 ft.).

3.8.2.19.3 Population and Abundance

Montipora caliculata are most often reported to be uncommon.

3.8.2.19.4 Predator-Prey Interactions

Montipora spp. are preferred prey of crown-of-thorns seastar.

3.8.2.19.5 Species-Specific Threats

Montipora caliculata is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Factors that contribute to *M. caliculata*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, wide overall distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.20 *Montipora lobulata* (Pore coral)

3.8.2.20.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the pore coral (*Montipora lobulata*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.20.2 Habitat and Geographic Range

Montipora lobulata has a disjoint distribution, with occurrence in the western and central Indian Ocean and the central Pacific. According to the International Union for Conservation of Nature and Natural Resources Species, *Montipora lobulata* occurs in American Samoa and the Northern Mariana Islands. The species account also lists its occurrence in the U.S. minor outlying islands (DeVantier et al. 2008b).

Montipora lobulata has been reported to inhabit shallow reef environments at depths of up to 20 m (65.6 ft.).

3.8.2.20.3 Population and Abundance

Abundance of *Montipora lobulata* has been reported as rare.

3.8.2.20.4 Predator-Prey Interactions

Montipora spp. are preferred prey of crown-of-thorns seastar.

3.8.2.20.5 Species-Specific Threats

Montipora lobulata is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Factors that contribute to *M. lobulata*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, overall wide distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.21 *Montipora patula* (Pore coral)

3.8.2.21.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the pore coral (*Montipora patula*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.21.2 Habitat and Geographic Range

Montipora patula has occurs in the Indo-West Pacific. The International Union for Conservation of Nature and Natural Resources Species Account also lists its occurrence in the U.S. minor outlying islands (DeVantier et al. 2008c).

Montipora patula has been reported to inhabit shallow reef environments at depths of up to at least 10 m (32.8 ft.).

3.8.2.21.3 Population and Abundance

Abundance of *Montipora patula* has been reported as rare.

3.8.2.21.4 Predator-Prey Interactions

Montipora spp. are preferred prey of crown-of-thorns seastar.

3.8.2.21.5 Species-Specific Threats

Montipora patula is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Factors that contribute to *M. patula*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, overall wide distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.22 *Pavona diffluens* (Leaf coral)

3.8.2.22.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the leaf coral (*Pavona diffluens*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.22.2 Habitat and Geographic Range

Pavona diffluens has a very narrow distribution, both latitudinal and longitudinal. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Pavona diffluens* has been recorded in the Northern Mariana Islands, but the records are considered unlikely (Hoeksema et al. 2008a).

These corals may be boulder shaped or encrusting, or more commonly plate or leaf like. They are common on protected reef slopes and in lagoons in water depths ranging from 5 to 20 m (16.4 to 65.6 ft.).

3.8.2.22.3 Population and Abundance

Abundance of *Pavona diffluens* has been reported as uncommon.

3.8.2.22.4 Predator-Prey Interactions

Species of the genus *Pavona* (Family Agaracidae) are susceptible to predation by crown-of-thorns seastar, but susceptibility is variable among species in the eastern Pacific. No information is available on the specific susceptibility of *Pavona diffluens*.

3.8.2.22.5 Species-Specific Threats

Pavona diffluens is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to the status of *P. diffluens* are: moderate vulnerability to ocean warming, disease, and acidification; uncommon generalized rangewide abundance; narrow overall distribution (based on narrow geographic range and moderate depth distribution); and inadequacy of existing regulatory mechanisms.

3.8.2.23 *Pachyseris rugosa* (Rugosa coral)

3.8.2.23.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the rugosa coral (*Pachyseris rugosa*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.23.2 Habitat and Geographic Range

Pachyseris rugosa has a very widespread distribution, stretching from the western Indian Ocean into the Pacific. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Pachyseris rugosa* occurs in American Samoa and the Northern Mariana Islands (Hoeksema et al. 2008b).

Pachyseris rugosa may develop into large mound-shaped colonies in shallow water in water depths ranging from 5 to 20 m (16.4 to 65.6 ft.). Smaller colonies occur in a wide range of habitats, including those exposed to strong wave action.

3.8.2.23.3 Population and Abundance

Abundance of *Pachyseris rugosa* has been reported as common.

3.8.2.23.4 Predator-Prey Interactions

Mass mortality of this species on the Great Barrier Reef has been attributed to *Acanthaster planci*, although predation was not observed directly.

3.8.2.23.5 Species-Specific Threats

Pachyseris rugosa is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to the status of *P. rugosa* are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, wide overall distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.24 *Euphyllia cristata* (Grape coral)

3.8.2.24.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the grape coral (*Euphyllia cristata*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.24.2 Habitat and Geographic Range

Euphyllia cristata has a moderately wide range, including higher latitude areas in the Ryukus (Japan) and along both coasts of Australia. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Euphyllia cristata* occurs in American Samoa and the Northern Mariana Islands (Turak et al. 2008a).

Euphyllia cristata inhabits shallow reef habitats; the International Union for Conservation of Nature and Natural Resources account includes a wide depth range of 1 to 35 m (3.3 to 114.8 ft.).

3.8.2.24.3 Population and Abundance

Abundance of *Euphyllia cristata* has been reported to range from common to uncommon but conspicuous.

3.8.2.24.4 Predator-Prey Interactions

Unknown for *Euphyllia cristata.*

3.8.2.24.5 Species-Specific Threats

Euphyllia cristata is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to the status of *Euphyllia cristata* are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification; uncommon generalized rangewide abundance, moderate overall distribution (based on moderate geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.25 *Euphyllia panaacora* (Grape coral)

3.8.2.25.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the grape coral (*Euphyllia panaacora*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.25.2 Habitat and Geographic Range

Euphyllia paraancora has a restricted range, both longitudinally and latitudinally. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Euphyllia paraancora* occurs in the Northern Mariana Islands (Turak et al. 2008b). The Convention on International Trade in Endangered Species of Wild Fauna and Flora database does not list its occurrence in U.S. waters.

Euphyllia paraancora has been reported from shallow and deep reef environments protected from wave action in water depths ranging from 3 to 30 m (9.8 to 98.4 ft.).

3.8.2.25.3 Population and Abundance

Abundance of *Euphyllia paraancora* has been reported to be uncommon.

3.8.2.25.4 Predator-Prey Interactions

Unknown for *Euphyllia paraancora.*

3.8.2.25.5 Species-Specific Threats

Euphyllia panaacora is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to the status of *E. paraancora* are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, wide overall distribution (based on moderate geographic distribution and wide depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.26 *Physogyra lichtensteini* (Grape coral)

3.8.2.26.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the grape coral (*Physogyra lichtensteini*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.26.2 Habitat and Geographic Range

Physogyra lichtensteini has a relatively broad distribution. It is found in Australia, Indonesia, Japan, Kenya, Madagascar, the Seychelles, the Red Sea, the Arabian Sea, India, the Philippines, and other areas in the west Pacific. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Physogyra lichtensteini* occurs in the Northern Mariana Islands (Turak et al. 2008c).

Physogyra lichtensteini has been reported to occupy turbid reef environments (Veron 2000). The species is common in protected habitats (crevices and overhangs), especially in turbid water with tidal currents in water depths ranging from 1 to 20 m (3.3 to 65.6 ft.).

3.8.2.26.3 Population and Abundance

Abundance of *Physogyra lichtensteini* has been reported to be common in protected habitats such as crevices and overhangs, especially in turbid water with tidal currents.

3.8.2.26.4 Predator-Prey Interactions

Population-level effects of predation are unknown for *Physogyra lichtensteini*, although it is preyed upon on by butterflyfish in Indonesia.

3.8.2.26.5 Species-Specific Threats

Physogyra lichtensteini is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to the status of *Physogyra lichtensteini* are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, wide overall distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.27 *Barabattoia laddi* (Faviid coral)

3.8.2.27.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species including a proposed listing for the faviid coral (*Barabattoia laddi*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.27.2 Habitat and Geographic Range

The range of *Barabattoia laddi* is somewhat restricted, latitudinally. It is highly centered in the Coral Triangle but also found around some of the islands in the western Pacific, central South Pacific, and Australia's Great Barrier Reef. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Barabattoia laddi* occurs in the Northern Mariana Islands (DeVantier et al. 2008d).

Barabattoia laddi has been recorded only from shallow lagoons in water depths ranging from 0 to 10 m (0 to 32.8 ft.).

3.8.2.27.3 Population and Abundance

Abundance of *Barabattoia laddi* has been reported to be rare.

3.8.2.27.4 Predator-Prey Interactions

Susceptibility to predation is unknown for *Barabattoia laddi*.

3.8.2.27.5 Species-Specific Threats

Barabattoia laddi is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to the status of Barabattoia laddi are: Moderate vulnerability to ocean warming, disease, and acidification; uncommon generalized rangewide abundance; narrow overall distribution (based on moderate geographic distribution and shallow depth distribution); and inadequacy of existing regulatory mechanisms.

3.8.2.28 *Millepora foveolata* (Fire coral)

3.8.2.28.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the fire coral (*Millepora foveolata*) as endangered (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.28.2 Habitat and Geographic Range

Millepora foveolata has been reported on the southern coast of Taiwan, the Philippines, the Northern Marianas but not the Southern Marianas which include Guam, Rota, Tinian, Saipan; and the Great Barrier Reef in Australia. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Millepora foveolata* occurs in American Samoa (Obura et al. 2008).

Specimens of *Millepora foveolata* have been collected from the forefront reef slope on the upper surface of buttress ridges and have been reported in water depths ranging from at least 1 to 8 m (3.3 to 26.2 ft.).

3.8.2.28.3 Population and Abundance

Abundance of *Millepora foveolata* has been reported mostly as occasional.

3.8.2.28.4 Predator-Prey Interactions

Species of the Milleporidae family are known to be preyed on by the crown-of-thorns seastar, although they are less preferred prey than members of the Acroporidae family. Milleporids are also susceptible to predation by the polychaete *Hermodice carunculata*, the nudibranch mollusk *Phyllidia*, and filefish of the genera *Alutera* and *Cantherhines.*

3.8.2.28.5 Species-Specific Threats

Millepora foveolata is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Millepora foveolata*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, narrow overall distribution (based on narrow geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.29 *Millepora tuberosa* (Fire coral)

3.8.2.29.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the fire coral (*Millepora tuberosa*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.29.2 Habitat and Geographic Range

Millepora tuberosa is occasionally common in portions of the western Pacific (Taiwan, Mariana lslands, Caroline Islands) and is found in American Samoa.

Millepora tuberosa has been reported to occupy a variety of habitats, including the forest reef and lagoonal areas in water depths ranging from at least 1 to 12 m (3.3 to 39.4 ft.).

3.8.2.29.3 Population and Abundance

Abundance of *Millepora tuberosa* has most often been reported as occasional, but it has been observed as predominant in an area of lagoonal reef in southwest Guam near the Agat Boat Harbor.

3.8.2.29.4 Predator-Prey Interactions

Species of the Milleporidae family are known to be preyed on by the crown-of-thorns seastar, although they are less preferred prey than members of the Acroporidae family. Milleporids are also susceptible to predation by the polychaete *Hermodice carunculata*, the nudibranch mollusk *Phyllidia*, and filefish of the genera *Alutera* and *Cantherhines.*

3.8.2.29.5 Species-Specific Threats

Millepora tuberosa is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Millepora tuberosa's* status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, narrow overall distribution (based on narrow geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.30 *Acanthastrea brevis* (Starry Cup coral)

3.8.2.30.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the starry cup coral (*Acanthastrea brevis*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.30.2 Habitat and Geographic Range

Acanthastrea brevis has wide distribution ranging from the Red Sea, Gulf of Aden, southwest Indian Ocean, and northern Indian Ocean to central Indo-Pacific, west Pacific, Great Barrier Reef, and Fiji. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Acanthastrea brevis* occurs in American Samoa and in the northern Mariana Islands (Turak et al. 2008d). No supporting reference is given in the species account for the stated record of occurrence in the Northern Mariana Islands.

Acanthastrea brevis has been reported to occupy shallow reef environments (Veron 2000) and all types of reef habitats. *Acanthastrea brevis* has been reported at water depths ranging from 1 to 20 m (3.3 to 65.6 ft.).

3.8.2.30.3 Population and Abundance

Abundance of *Acanthastrea brevis* has been reported as uncommon but conspicuous.

3.8.2.30.4 Predator-Prey Interactions

The specific predation threats upon members of the Family Mussidae (*Acanthastrea* sp.) found in the MITT Study Area are unknown (Brainard et al. 2011).

3.8.2.30.5 Species-Specific Threats

Acanthastrea brevis is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to the status of *Acanthatsrea brevis* are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, wide overall distribution (based on wide geographic range and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.31 *Acanthastrea ishigakiensis* (Starry Cup coral)

3.8.2.31.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the starry cup coral (*Acanthastrea ishigakiensis*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.31.2 Habitat and Geographic Range

Acanthastrea ishigakiensis has a broad range; it stretches from the Red Sea, Gulf of Aden, and southern Africa to the central Pacific Ocean as far as Samoa but not including Australia. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Acanthastrea ishigakiensis* occurs in American Samoa and the Northern Mariana Islands, but no supporting reference is given for the record of occurrence in either of these areas in the species account.

Acanthastrea ishigakiensis has been reported to occupy shallow protected reef environments in water depths ranging from 1 to 15 m (3.3 to 49.2 ft.).

3.8.2.31.3 Population and Abundance

Abundance of *Acanthastrea ishigakiensis* has been reported as uncommon but conspicuous.

3.8.2.31.4 Predator-Prey Interactions

The specific predation threats upon members of the Family Mussidae (Acanthastrea sp.) found in the MITT Study Area are unknown (Brainard et al. 2011).

3.8.2.31.5 Species-Specific Threats

Acanthastrea ishigakiensis is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to the status of *A. ishigakiensis* are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, moderate overall distribution (based on wide geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.32 *Acanthastrea regularis* (Starry Cup coral)

3.8.2.32.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the starry cup coral (*Acanthastrea regularis*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.32.2 Habitat and Geographic Range

Distribution is fairly restricted both longitudinally as latitudinally. It is highly centered in the Coral Triangle but also found around some of the islands in the west Pacific and Australia's Great Barrier Reef. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Acanthastrea regularis* occurs in the Northern Mariana Islands, but no supporting reference is given.

Acanthastrea regularis has been reported to occupy shallow reef environments in water depths ranging from 2 to 20 m (6.6 to 65.6 ft.).

3.8.2.32.3 Population and Abundance

Abundance of *Acanthastrea regularis* has been reported as uncommon.

3.8.2.32.4 Predator-Prey Interactions

The specific predation threats upon members of the Family Mussidae (*Acanthastrea* sp.) found in the MITT Study Area are unknown (Brainard et al. 2011).

3.8.2.32.5 Species-Specific Threats

Acanthastrea regularis is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to the status of *Acanthastrea regularis* are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, moderate overall distribution (based on moderate geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.33 *Pectinia alcicornis* (Lettuce coral)

3.8.2.33.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the lettuce coral (*Pectina alcicornis*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.33.2 Habitat and Geographic Range

Pectinia alcicornis is broadly distributed in the Indo-Pacific, including Australia, Fiji, Indonesia, Japan, the Philippines, and India. U.S.-affiliated waters within the Indo-West Pacific range include American Samoa, the Marshall Islands, Micronesia, the Northern Mariana Islands, Palau, and unspecified U.S. minor outlying islands.

Pectinid corals can be found in turbid, horizontal reef environments to approximately 25 m (82.0 ft.) deep.

3.8.2.33.3 Population and Abundance

Abundance of *Pectinia alcicornis* has been reported as usually uncommon.

3.8.2.33.4 Predator-Prey Interactions

Members of the Pectinidae family are highly susceptible to crown-of-thorns seastar. However, little is known about the potential population-level impacts for *Pectinia alcicornis*.

3.8.2.33.5 Species-Specific Threats

Pectina alcicornis is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to the status of *Pectinia alcicornis* are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, wide overall distribution (based on wide geographic range and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.34 *Pocillopora danae* (Cauliflower coral)

3.8.2.34.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the cauliflower coral (*Pocillopora danae*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.34.2 Habitat and Geographic Range

Pocillopora danae has a somewhat broad longitudinal and latitudinal range. It has been reported throughout the western Pacific and a small part of the central Pacific, the Great Barrier Reef, and around Sri Lanka. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Pocillopora danae* has been recorded in the Northern Mariana Islands (Hoeksema et al. 2008c).

Pocillopora danae has been reported on partly protected reef slopes in water depths ranging from 1 to 15 m (49.2 ft.).

3.8.2.34.3 Population and Abundance

Abundance of *Pocillopora danae* has usually been reported to be uncommon.

3.8.2.34.4 Predator-Prey Interactions

Species of the Pocilloporidae family are among the most commonly consumed coral genera by crown-of-thorns seastar (*Acanthaster planci*) (Glynn 1976). However, Pocillopora are defended from Acanthaster predation by two mutualistic crustacean symbionts: a crab and a snapping shrimp, which often form protective barriers around unprotected species (Glynn 1976). Because smaller colonies lack these symbionts, Acanthaster often target young colonies, potentially reducing recruit success. Additionally, Pocillopora has been identified as preferred prey for corallivorous invertebrates such as the asteroid *Culcita novaeguineae* (Brainard et al. 2011), the gastropod *Jenneria pustulata* (Glynn 1976), and corallivorous fishes.

3.8.2.34.5 Species-Specific Threats

Pocillopora danae is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Pocillopora danae*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, moderate overall distribution (based on moderate geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.35 *Pocillopora elegans* (Cauliflower coral)

3.8.2.35.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the cauliflower coral (*Pocillopora elegans*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.35.2 Habitat and Geographic Range

The global distribution of *Pocillopora elegans* is rather fragmented; it is found in the central Indo-Pacific, the Marianas and central Pacific, and along the coastline of the eastern tropical Pacific and the Galapagos Islands. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Pocillopora elegans* has been recorded in American Samoa and the Northern Mariana Islands (Hoeksema et al. 2008d). The species account also lists its occurrence in the U.S. minor outlying islands.

Pocillipora elegans has been reported from shallow reef in water depths ranging from 1 to 20 m (3.3 to 65.6 ft.). However, it has been found at a depth of 60 m (196.9 ft.), suggesting the potential for deep refugia.

3.8.2.35.3 Population and Abundance

Abundance of *Pocillipora elegans* has been reported to be locally common in some regions of the central Indo-Pacific and the far eastern Pacific.

3.8.2.35.4 Predator-Prey Interactions

Species of the Pocilloporidae family are among the most commonly consumed coral genera by crown-of-thorns seastar (*Acanthaster planci*). Additionally, Pocillopora has been identified as preferred prey for corallivorous invertebrates such as the asteroid *Culcita novaeguineae* (Brainard et al. 2011), the gastropod *Jenneria pustulata* (Glynn 1976), and corallivorous fishes.

3.8.2.35.5 Species-Specific Threats

Pocillopora elegans is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population’s demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *P. elegans*’ (Indo-Pacific) status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, wide overall distribution (based on wide geographic distribution and wide depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.36 *Seriatopora aculeata* (Bird Nest coral)

3.8.2.36.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the bird nest coral (*Seriatopora aculeata*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.36.2 Habitat and Geographic Range

Seriatopora aculeata has a relatively confined distribution. It has been reported primarily from the Indo-Pacific, including Australia, Fiji, Indonesia, Japan, and Papua New Guinea. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Seriatopora aculeata* has been recorded in the Northern Mariana Islands (Hoeksema et al. 2008e).

Seriatopora aculeata has been reported to occupy shallow reef environments in water depths ranging from 3 to 40 m (9.8 to 131.2 ft.).

3.8.2.36.3 Population and Abundance

Abundance of *Seriatopora aculeata* has been reported as uncommon.

3.8.2.36.4 Predator-Prey Interactions

The specific effects of predation are poorly known for *Seriatopora aculeata*. The genus Seriatopora is known to be susceptible to predation by snails and the crown-of-thorns seastar (*Acanthaster planci*).

3.8.2.36.5 Species-Specific Threats

Seriatopora aculeata is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Seriatopora aculeata*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon generalized rangewide abundance, moderate overall distribution (based on moderate geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.37 *Alveopora allingi* (Net coral)

3.8.2.37.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the net coral (*Alveopora allingi*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.37.2 Habitat and Geographic Range

Alveopora allingi has a very broad range, extending from the Red Sea and East Africa to the central Pacific. It extends latitudinally from the Japanese Ryukyu Islands and Red Sea in the northern hemisphere across the Great Barrier Reef and down both coastlines of Australia and South Africa in the southern hemisphere. According to both the International Union for Conservation of Nature and Natural Resources Species Account, *Alveopora allingi* occurs in American Samoa, the Northern Mariana Islands and U.S. minor outlying islands (Sheppard et al. 2008a).

Alveopora allingi has been reported to occupy protected reef environments in water depths ranging from 5 to 10 m (16.4 to 32.8 ft.).

3.8.2.37.3 Population and Abundance

Abundance of *Alveopora allingi* has been reported as usually uncommon.

3.8.2.37.4 Predator-Prey Interactions

The specific predation threats upon Alveopora allingi are unknown (Brainard et al. 2011). However, species of the Portidae family (e.g., *Porites, Alveopora* spp.) are susceptible to crown-of-thorns seastar and corallivorous snail predation. Porites are susceptible, but are not a preferred prey, of the predatory asteroid *Culcita novaeguineae* and the butterflyfish *Chaetodon unimaculatus*.

3.8.2.37.5 Species-Specific Threats

Alveopora allingi is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Alveopora allingi*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon relative rangewide abundance, moderate overall distribution (based on wide geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.38 *Alveopora fenestrata* (Net coral)

3.8.2.38.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the net coral (*Alveopora fenestrata*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.38.2 Habitat and Geographic Range

Alveopora fenestrata has a relatively broad range. Longitudally it stretches from the Red Sea to the oceanic west Pacific and latitudinally from the Red Sea and the Northern Mariana Islands on the northern hemisphere to southern Africa and across both coasts of Australia in the Southern hemisphere. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Alveopora fenestrata* occurs in the Northern Mariana Islands (Sheppard et al. 2008b).

Alveopora fenestrata has been reported to occupy shallow reef environments in water depths ranging from 3 to 30 m (9.8 to 98.4 ft.).

3.8.2.38.3 Population and Abundance

Abundance of *Alveopora fenestrata* has been reported as uncommon.

3.8.2.38.4 Predator-Prey Interactions

The specific predation threats upon *Alveopora fenestrata* are unknown (Brainard et al. 2011). However, species of the Portidae family (e.g. *Porites, Alveopora* spp.) are susceptible to crown-of-thorns seastar and corallivorous snail predation. Porites are susceptible, but are not a preferred prey, of the predatory asteroid *Culcita novaeguineae* and the butterflyfish *Chaetodon unimaculatus*.

3.8.2.38.5 Species-Specific Threats

Alveopora fenestrate is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Alveopora fenestrata*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon relative rangewide abundance, wide overall distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.39 *Alveopora verrilliana* (Net coral)

3.8.2.39.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the net coral (*Alveopora verrilliana*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.39.2 Habitat and Geographic Range

Alveopora verrilliana has a broad range. It stretches from the Red Sea to the central Pacific Ocean longitudinally and latitudinally from the Japanese Ryukyu Islands in the northern hemisphere and midway along both Australian coasts in the southern hemisphere. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Alveopora verrilliana* occurs in American Samoa, the Northern Mariana Islands, and minor outlying islands (Sheppard et al. 2008c).

Alveopora verrilliana has been reported to occupy shallow reef environments in water depths ranging from 3 to 40 m (9.8 to 131.2 ft.). It has also been reported on outer steep slopes from 20 to 80 m (65.6 to 262.5 ft.) deep in the Red Sea, suggesting the potential for deep refugia.

3.8.2.39.3 Population and Abundance

Abundance of *Alveopora verrilliana* has been reported to be uncommon.

3.8.2.39.4 Predator-Prey Interactions

The specific predation threats upon *Alveopora verrilliana* are unknown (Brainard et al. 2011). However, species of the Portidae family (e.g., Porites, *Alveopora* spp.) are susceptible to crown-of-thorns seastar and corallivorous snail predation. Porites are susceptible, but are not a preferred prey, of the predatory asteroid *Culcita novaeguineae* and the butterflyfish *Chaetodon unimaculatus*.

3.8.2.39.5 Species-Specific Threats

Alveopora verrilliana is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Alveopora verrilliana*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, uncommon relative rangewide abundance, wide overall distribution (based on wide geographic distribution and wide depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.40 *Porites horizontalata* (Hump coral)

3.8.2.40.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the hump coral (*Porites horizontalata*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.40.2 Habitat and Geographic Range

The range of *Porites horizontalata* is somewhat restricted longitudinally from the Maldives in the west to the central Pacific in the east and latitudinally from south of Japan in the northern hemisphere to New Caledonia in the southern hemisphere. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Porites horizontalata* has been recorded in American Samoa and the Northern Mariana Islands (Sheppard et al. 2008d). The species account also lists this species in the U.S. minor outlying islands.

Porites horizontalata has been reported to occupy shallow reef environments in water depths ranging from 5 to 20 m (16.4 to 65.6 ft.). It is also known to range in depth from moderate to deep water in American Samoa and in New Caledonia.

3.8.2.40.3 Population and Abundance

Abundance of *Porites horizontalata* has been reported as sometimes common.

3.8.2.40.4 Predator-Prey Interactions

Porites is susceptible to crown-of-thorns seastar (*Acanthaster planci*) and corallivorous snail predation including predation of *Coralliphilia violacea* on both massive and branching forms. Massive Porites are susceptible, but not a preferred prey, of the predatory asteroid *Culcita novaeguineae* and the butterflyfish *Chaetodon unimaculatus*.

3.8.2.40.5 Species-Specific Threats

Porites horizontalata is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Porites horizontilata*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, wide overall distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.41 *Porites napopora* (Hump coral)

3.8.2.41.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the hump coral (*Porites napopora*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.41.2 Habitat and Geographic Range

Range is somewhat restricted both longitudinally and latitudinally, limited to the west and central Pacific, particularly the Coral Triangle area. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Porites napopora* occurs in the Northern Mariana Islands (Sheppard et al. 2008e).

Porites napopora has been reported to occupy shallow reef environments in water depths ranging from 3 to 15 m (9.8 to 49.2 ft.).

3.8.2.41.3 Population and Abundance

Abundance of *Porites napopora* has been reported as sometimes common.

3.8.2.41.4 Predator-Prey Interactions

Porites is susceptible to crown-of-thorns seastar (*Acanthaster planci*) and corallivorous snail predation including predation of *Coralliphilia violacea* on both massive and branching forms. Massive Porites are susceptible, but not a preferred prey, of the predatory asteroid *Culcita novaeguineae* and the butterflyfish *Chaetodon unimaculatus*.

3.8.2.41.5 Species-Specific Threats

Porites napopora is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to *Porites napapora*'s status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, narrow overall distribution (based on moderate geographic distribution and shallow depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.42 *Porites nigrescens* (Hump coral)

3.8.2.42.1 Status and Management

In December 2012, NMFS issued a proposed rule for reef-building coral species, including a proposed listing for the hump coral (*Porites nigrescens*) as threatened (77 FR 73220–73262). NMFS has not proposed a critical habitat designation. The proposed listing is based on a comprehensive status review (Brainard et al. 2011), a summary of management and conservation measures, and a supplemental information report addressing new information and public comment to both status and management reports (National Marine Fisheries Service 2012).

3.8.2.42.2 Habitat and Geographic Range

The distribution is broad longitudinally, ranging from the east coast of Africa to the central Pacific and broad latitudinally ranging from the Red Sea and south of Japan in the northern hemisphere to halfway down both coastlines of Australia in the southern hemisphere. According to the International Union for Conservation of Nature and Natural Resources Species Account, *Porites nigrescens* has been recorded in American Samoa (Sheppard et al. 2008f). The species account also lists this species in the Northern Mariana Islands and the U.S. minor outlying islands.

Porites nigrescens has been reported to occupy lower reef slopes and lagoons protected from wave action at moderate depths ranging from 0.5 to 20 m (1.6 to 65.6 ft.).

3.8.2.42.3 Population and Abundance

Porites nigrescens has been reported as sometimes common. Where found, it can be a part of a locally abundant branching Poritiid assemblage.

3.8.2.42.4 Predator-Prey Interactions

Porites is susceptible to crown-of-thorns seastar (*Acanthaster planci*) and corallivorous snail predation including predation of *Coralliphilia violacea* on both massive and branching forms. Massive Porites are susceptible, but not a preferred prey, of the predatory asteroid *Culcita novaeguineae*, and the butterflyfish *Chaetodon unimaculatus*.

3.8.2.42.5 Species-Specific Threats

Porites nigrescens is susceptible to the same suite of stressors that generally threaten corals. NMFS evaluated the population's demographic, spatial structure, and vulnerability factors (77 FR 73220–73262). Elements that contribute to Porites nigrescens' status are: high vulnerability to ocean warming, moderate vulnerability to disease and acidification, common generalized rangewide abundance, wide overall distribution (based on wide geographic distribution and moderate depth distribution), and inadequacy of existing regulatory mechanisms.

3.8.2.43 Taxonomic Group Descriptions

3.8.2.43.1 Phylum Cnidaria (e.g., Corals, Hydroids, Jellyfish)

There are over 10,000 marine species of corals, hydroids, and jellyfish worldwide (Appeltans et al. 2010). Members of this group are found throughout the Study Area at all depths. Hydroids are colonial animals that can have both flexible and rigid skeletons, but are not considered to be habitat-forming as corals are in creating reefs (Colin and Arneson 1995a; Gulko 1998). Jellyfish are motile as larvae, sessile as an intermediate colonial polyp stage, and motile as adults (Brusca and Brusca 2003). They are predatory at all stages and, like all Cnidaria, use tentacles equipped with stinging cells to capture prey (Castro and Huber 2000; University of California at Berkeley 2010a). Jellyfish are an important prey species to a range of organisms, including some sea turtles and some ocean sunfish (*Mola mola*) (Heithaus et al. 2002; James and Herman 2001).

The class Anthozoa includes anemones and corals (hard and soft). The individual unit of corals is a polyp, and most species occur as colonies of polyps. Corals can feed on plankton, which are small organisms that float with the currents, as well as other small organisms. Corals capture prey with tentacles that surround their mouth and are armed with stinging cells (Brusca and Brusca 2003). Reef-building corals occur in the photic zone (defined by the depth of light penetration) of coastal waters, typically shallower than approximately 650 ft. (200 m), and usually host symbiotic algae called zooxanthellae that provide nutrition to the corals as byproducts from photosynthesis (Veron and Stafford-Smith 2011; Castro and Huber 2000) and give the coral its color. The zooxanthellae receive shelter from the coral as well as carbon dioxide needed for photosynthesis. All corals feed on small planktonic organisms or dissolved organic matter, although some shallow-water corals derive most of their energy from their symbiotic algae (Dubinsky and Berman-Frank 2001). Most hard corals and some soft corals are habitat-forming (i.e., they form coral reefs) (Freiwald et al. 2004; Spalding et al. 2001; South Atlantic Fishery Management Council 1998).

Many corals can reproduce either sexually or asexually. Some are hermaphrodites, meaning that they possess both male and female reproductive organs. Most species reproduce sexually by releasing eggs and sperm into the water (spawning), where fertilization occurs and larvae begin to develop. After larvae settle on an appropriate surface, the colony begins to grow (Boulon et al. 2005). Fragmentation is a common form of asexual reproduction in species with thin branches. During a storm, thin branches typically break off from a colony and form new colonies by attaching to a suitable surface (Richmond 1997). Although fragmentation helps maintain high growth rates, it reduces the reproductive potential of some coral species by delaying the production of eggs and sperm for years following the damage (Lirman 2000).

Predation on some coral genera, especially *Acropora, Montipora, Pocillopora*, and *Porites* in the Pacific, by many species of fish and invertebrates is a consistent threat to corals and has been identified for most coral life stages (Brainard et al. 2011). So far, 128 species of fish spread across 11 families have been found to prey on corals, with a third of the species relying on corals for more than 80 percent of their diet. Several experimental field studies have demonstrated that the distribution of corals was directly limited by predation of corallivorous fishes and invertebrates. Predation of corals by fishes and invertebrates is normally considered negative, but triggerfish and pufferfish have been shown to disperse coral fragments during feeding, potentially helping corals spread by asexual reproduction. Some predators also affect the distribution of corals by preferentially consuming coral species or forms that are the faster-growing and thereby superior competitors for space (e.g., *Acropora, Montipora, Pocillopora*, and branching *Porites*). For example, one study found that by reducing the growth of the superior competitor (e.g., *Montipora capitata*), predators allow the more slowly growing coral (*Porites compressa*) to prevail (Cox 1986).

Apart from a few exceptions, coral reefs in the Pacific Ocean are confined to the warm tropical and subtropical waters between 30 degrees (°) North (N) and 30° South (S). Over 400 scleractinian (stony corals) and hydrozoan coral species (hydrocorals), representing 22 families and 108 genera have, been identified from Guam and the Mariana Islands (Randall 2003). Of this total number, 377 are scleractinian species that occur within 20 families and 99 genera and 26 are hydrozoan species that occur within 2 families and 9 genera. About 70 percent of the coral fauna (281 species) contain zooxanthellae in their tissues and about 30 percent (122 species) are azooxanthellate, although several genera (contain both azooxanthellate and zooxanthellae species) (Randall 2003). Azooxanthellate obtain energy from detritus, zooplankton, and nekton they capture from the surrounding water. Since azooxanthellate corals do not depend on sunlight or a symbiotic existence with zooxanthellae, they can be found in deeper waters (National Marine Fisheries Service 2010c).

Deep-sea coral communities are prevalent throughout the Mariana Islands chain, and often form offshore reefs. Much like shallow-water corals, deep-sea corals are fragile, slow growing, and can survive for hundreds of years. In the Mariana Islands, gorgonians, while occurring at all depths, are the most commonly found corals in deep-sea communities. Gorgonian diversity and abundance increase below 30 m (98.4 ft.), especially in steep, cavernous, and current-swept areas, so that about 20 species are known between 30 and 60 m (98.4 and 196.9 ft.) (Pauley et al. 2003). Several of the gorgonian species listed have been encountered at diving depths only in caverns along the southern Orote Peninsula of Guam, especially the Blue Hole; these species are otherwise restricted to deeper water. In contrast, the much richer deep-water fauna remains poorly known. Gorgonians, the soft coral genera *Siphonogorgia* and *Dendronephthya*, and black corals become much more diverse and abundant below 60 m (196.9 ft.). Dredging and tangle net surveys (Eldredge 2003) have already revealed about 70 species of arborescent octocorals at 60 to 400 m (196.9 to 1,312.3 ft.) and many others surely remain to be collected.

There is evidence that overall coral reef habitat has declined in the Study Area, and this is used as a proxy for population decline in many species. Species that are particularly susceptible to bleaching, disease, and other threats are more susceptible to further decline; therefore, population decline is based on both the percentage of destroyed reefs and the percentage of critical reefs that are likely to be destroyed within 20 years (Wilkinson 2004).

3.8.2.43.2 Phylum Platyhelminthes (Flatworms)

Flatworms include between 8,000 and 20,000 marine species worldwide (Appeltans et al. 2010; Castro and Huber 2000) and are the simplest form of marine worm (Castro and Huber 2000). The largest single group of flatworms are parasites commonly found in fishes, seabirds, and whales (Castro and Huber 2000; University of California Berkeley 2010b). The life history of parasitic flatworms plays a role in the regulation of populations for the marine vertebrates they inhabit. Ingestion by the host organism is the primary dispersal method for parasitic flatworms. As parasites, they are not typically found in the water column, outside of a host organism. The remaining groups are non-parasitic carnivores, living without a host. Flatworms are found throughout the Study Area living on rocks in tidepools and reefs, within the top layer of sandy areas, or planktonic. Eighty-eight species of flatworms have been identified from surveys and from literature records in and around Guam (Newman and Ritson-Williams 2003); however, due to the difficulty in taxonomic determinations, the authors believe there may be in excess of 100 species.

3.8.2.43.3 Phylum Nemertea (Ribbon Worms)

Ribbon worms include approximately 1,000 marine species worldwide (Appeltans et al. 2010). Ribbon worms, with their distinct gut and mouth parts, are more complex than flatworms (Castro and Huber 2000). Organisms in this phylum are bottom-dwelling, predatory marine worms that are equipped with a long extension from the mouth (i.e., a proboscis) that helps them capture food (Castro and Huber 2000). Some species are also equipped with a sharp needle-like structure that delivers poison to kill prey. Ribbon worms occupy an important place in the marine food web as prey for a variety of fish and invertebrates and as a predator of other bottom-dwelling organisms, such as worms and crustaceans (Castro and Huber 2000). Some ribbon worms occupy the inside of the mantle of molluscs where they feed on the waste products of their host (Castro and Huber 2000). Eight species of ribbon worms have been found within the Study Area (Paulay 2003a).

3.8.2.43.4 Phylum Nematoda (Round Worms)

Round worms include over 5,000 marine species, though this number may be significantly underestimated (Appeltans et al. 2010). Round worms are small and cylindrical, and are abundant in sediments and can also be found in host organisms as parasites (Castro and Huber 2000). Round worms are one of the most widespread marine invertebrates, with population densities of up to one million organisms per 11 square feet ($ft.^2$) (1.02 square meters [m^2]) of mud (Levinton 2009). This group has a variety of food preferences, including algae, small invertebrates, annelid worms, and organic material from sediment. Like parasitic flatworms, parasitic nematodes provide important ecosystem services by regulating populations of other marine organisms by causing illness or mortality in less viable organisms. Species in the family Anisakidae infect marine fish, and may cause illness in humans if fish are consumed raw without proper precautions. Round worms are found throughout the Study Area.

3.8.2.43.5 Phylum Annelida (Segmented Worms)

Segmented worms include approximately 12,000 marine species worldwide in the phylum Annelida, although most marine forms are in the class Polychaeta (Appeltans et al. 2010). Segmented worms are the most physiologically complex group of marine worms with a well developed respiratory and gastrointestinal system (Castro and Huber 2000). Different species of segmented worms may be highly mobile or burrow in the seafloor (Castro and Huber 2000). Most segmented worms are predators; others are scavengers, deposit feeders, filter feeders, or suspension feeders of sand, sediment, and water (Hoover 1998c). The variety of feeding strategies and close connection to the seafloor make Annelids an integral part of the marine food web (Levinton 2009). Burrowing in the seafloor and agitating the sediment increases the oxygen content of seafloor sediments and makes important buried nutrients available to other organisms. This ecosystem service allows bacteria and other organisms, which are also an important part of the food web, to flourish on the seafloor. Segmented worms are found throughout the Study Area inhabiting rocky, sandy, and muddy areas of the seafloor. These worms also colonize on corals, vessel hulls, docks, and floating debris.

3.8.2.43.6 Phylum Mollusca (e.g., Squid, Bivalves, Sea Snails, Chitons)

There are approximately 27,000 marine species that are classified in the Phylum Mollusca worldwide (Appeltans et al. 2010). Gastropods (e.g., sea snails), bivalves (e.g., mussels), cephalopods (e.g. squid), and chitons (polyplacophorans) are marine invertebrates that possess a muscular organ called a foot, which is used for mobility (Castro and Huber 2000). Sea snails and slugs eat fleshy algae and a variety of invertebrates, including hydroids, sponges, sea urchins, worms, other snails, and small crustaceans, as well as detritus (Castro and Huber 2000; Colin and Arneson 1995c). Clams, mussels, and other bivalves feed on suspended food particles (e.g., phytoplankton, detritus) (Castro and Huber 2000). Chitons, sea snails, and slugs use rasping tongues, known as radula, to scrape food (e.g., algae) off rocks (Castro and Huber 2000; Colin and Arneson 1995c). Squid and octopus are active swimmers at all depths and use a beak to prey on a variety of organisms, including fish, shrimp, and other invertebrates (Castro and Huber 2000; Hoover 1998c; Western Pacific Regional Fishery Management Council 2001). Octopuses mostly prey on fish, shrimp, eels, and crabs (Wood and Day 2005).

Creel surveys (estimates of local fisheries catch data) have shown that the main species collected within the shore-based harvesting are octopus (*Octopus cyanea, O. ornatus*) and topsnail (*Tectus niloticus*). Important species of Mollusca, as indicated by creel surveys of boat-based harvesting show that the highest catches are of octopus (*Octopus cyanea*, *O. ornatus*, and *O. teuthoides*), topsnail (*Trochus niloticus*), giant spider conch (*Lambis truncata*), and bigfin reef squid (*Sepioteuthis lessoniana*) (Burdick et al. 2008).

3.8.2.43.7 Phylum Arthropoda (e.g., Shrimp, Crab, Lobster, Barnacles, Copepods)

Shrimp, crabs, lobsters, barnacles, and copepods are animals with skeletons on the outside of their body (exoskeleton) (Castro and Huber 2000), and are classified as crustaceans in the Phylum Arthropoda, which also includes insects and arachnids. Shrimp, crabs, and lobsters are typically carnivores, omnivorous predators, or scavengers, preying on molluscs (primarily gastropods), other crustaceans, echinoderms, small fish, algae, and sea grass (Waikiki Aquarium 2009a, b, c; Western Pacific Regional Fishery Management Council 2009). Barnacles and copepods filter algae and other small organisms from the water (Levinton 2009).

Important recreational species of Crustacea, as indicated by creel surveys of the shore-based fishery, are lobster (*Panulirus penicillatus*), slipper lobster (*Parribacus antarticus*) and crab (*Scylla serrate*). The important harvested species of the boat-based fishery are lobster (*Panulirus penicillatus, P. versicolor*), and slipper lobster (*Parribacus antarticus*) (Burdick et al. 2008).

3.8.2.43.8 Phylum Echinodermata (e.g., Sea Stars, Sea Urchins, Sea Cucumbers)

Organisms in this phylum include over 6,000 marine species, such as sea stars, sea urchins, and sea cucumbers (Appeltans et al. 2010). Asteroids (e.g., sea stars), sechinoids (e.g., sea urchins), holothuroids (e.g., sea cucumbers), ophuiroids (e.g., brittle stars and basket stars), and crinoids (e.g., feather stars and sea lilies) are symmetrical around the center axis of the body (Castro and Huber 2000). Echinoderms occur at all depth ranges from the intertidal zone to the abyssal zone and are almost exclusively benthic (living on the sea floor). Most echinoderms have separate sexes, but unisexual forms occur among the sea stars, sea cucumbers, and brittle stars. Many species have external fertilization, producing planktonic larvae, but some brood their eggs, never releasing free-swimming larvae (Colin and Arneson 1995b). Many echinoderms are either scavengers or predators on organisms that do not move, such as algae, stony corals, sponges, clams, and oysters (Hoover 1998b), although some also predate on other species of seastars. Some species, however, filter food particles from sand, mud, or water.

Important commercial, ecological, and recreational species in the shore-based fishery of Guam are the sea urchins (*Tripneustes gratilla* and *Toxipneustes pilolus*) (Burdick et al. 2008) and sea cucumbers (Kinch et al. 2008).

3.8.2.43.9 Phylum Porifera (Sponges)

Sponges include over 8,000 marine species worldwide, and are classified in the Phylum Porifera (Appeltans et al. 2010). Sponges are bottom-dwelling, multi-cellular animals that can be best described as an aggregation of cells that perform different functions. Sponges are largely sessile (not mobile), except for their larval stages, and are common throughout the Study Area at all depths. This filtering process is an important coupler of pelagic and benthic processes (Perea-Blázquez et al. 2012). Sponges reproduce both sexually and asexually. Water flowing through the sponge provides food and oxygen and removes wastes (Castro and Huber 2000; Collins and Waggoner 2006). Many sponges form calcium carbonate or silica spicules or bodies embedded in cells to provide structural support (Castro and Huber 2000). Sponges provide homes for a variety of animals, including shrimp, crabs, barnacles, worms, brittle stars, holothurians, and other sponges (Colin and Arneson 1995d). Over 100 species of siliceous sponges (Class Demospongiae) and 4 species of the calcareous sponges (Class Calcarea) have been identified from the marine waters of the Mariana Islands (Kelly et al. 2003).

3.8.2.43.9.1 Kingdom Protozoa (e.g., Foraminifera, Radiolarians, Ciliates)

Foraminifera, radiolarians, and ciliates are minute singled-celled organisms, sometimes forming colonies of cells, belonging to the Kingdom Protozoa (Castro and Huber 2000). They are found in the water column and seafloor of the world's oceans. Forminifera form diverse and intricate shells out of calcium carbonate (Wetmore 2006). The shells of formanifera that live in the water column eventually sink to the deep seafloor, forming sediments known as formaminiferan ooze. Four new species of foraminifera were recently discovered in the Challenger Deep at a depth of over 10,800 m (35,400 ft.) in the Marianas Trench (Gooday et al. 2008). Foraminifera feed on diatoms and other small organisms. Their predators include copepods and other zooplankton. Radiolarians are microscopic organisms that form shells made of silica. Radiolarian ooze covers large areas of the ocean floor (Castro and Huber 2000; Wetmore 2006). Ciliates are protozoans with small hair-like extensions that are used to feed and move around. Over 300 species of the clade Foraminifera occur in the substrate and marine waters surrounding Guam (Richardson and Clayshulte 2003). However, while species of protozoans have been identified within the MITT Study Area, direct measurements of abundance are not readily available.

3.8.3 ENVIRONMENTAL CONSEQUENCES

This section presents the analysis of potential impacts on marine invertebrates, from implementation of the project alternatives, including the No Action Alternative, Alternative 1, and Alternative 2. U.S. Department of the Navy (Navy) training and testing activities are evaluated for their potential impact on marine invertebrates in general, by taxonomic groups, and in detail for species listed under the ESA (Section 3.8.2, Affected Environment).

The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to marine invertebrates in the study area and analyzed below include the following:

- Acoustic (sonar and other active acoustic sources; underwater explosives; swimmer defense airguns; weapons firing, launch and impact noise; aircraft noise; and vessel noise)
- Energy Stressors (electromagnetic devices)
- Physical disturbance and strike (vessels, in-water devices, military expended materials, and seafloor devices)
- Entanglement (Fiber optic cables and guidance wires, and decelerators/parachutes)
- Ingestion (munitions and military expended materials other than munitions)
- Secondary

The specific analysis of the training and testing activities presented in this section considers the relevant components and associated data within the geographic location of the activity (see Tables 2.8-1 through 2.8-4) and the resource.

3.8.3.1 Acoustic Stressors

Assessing whether sounds may disturb or injure an animal involves understanding the characteristics of the acoustic sources, the animals that may be near 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 invertebrates build upon the conceptual framework for assessing effects from sound-producing activities (Appendix H.1, Conceptual Framework for Assessing Effects from Sound-Producing Activities). Categories of potential impacts are direct trauma, hearing loss, auditory masking, behavioral reactions, and physiological stress. Little information is available on the potential impacts on marine invertebrates' exposure to sonar, explosions, and other sound-producing activities. Most studies focus on squid or crustaceans, and the consequences of exposures to broadband impulse air guns typically used for seismic exploration, rather than on sonar or explosions.

Direct trauma and mortality may occur due to the rapid pressure changes associated with an explosion. Most invertebrates lack air cavities that would respond to pressure waves, which typically causes the most damage in fish or marine mammals. Marine invertebrates could also be displaced, or in the case of delicate coral polyps or structures, damaged, by a shock wave.

To experience hearing impacts, masking, behavioral reactions, or physiological stress, a marine invertebrate must be able to sense sound. Marine invertebrates are likely only sensitive to water particle motion caused by nearby low-frequency sources, and likely do not hear or feel distant or mid- and high-frequency sounds. Lovel et al. (2005) determined hearing sensitivity in prawns to sounds between 100 Hz and 3 kHz (though the threshold levels were all above 100 dB re 1 μPa). No damage to statocysts (a sensory receptor in some aquatic invertebrates) and no impacts on crustacean balance (a function of the statocyst) were observed in crustaceans repeatedly exposed to high-intensity airgun firings (Christian et al. 2003; Payne et al. 2007). The limited information suggests that marine invertebrate statocysts may be resistant to impulse sound impacts, but that the impact of long-term or non-impulse sound exposures is undetermined.

Masking occurs when a sound interferes with an animal's ability to detect other biologically relevant sounds in its environment. Little is known about how marine invertebrates use sound in their environment. Some studies have shown that crab and coral larvae and post-larvae may use nearby reef sounds when in their settlement phase (Jeffs et al. 2003; Radford et al. 2007; Stanley et al. 2010; Vermeij et al. 2010), although it is unknown what component of reef noise is used. Larvae likely sense particle motion of nearby sounds, limiting their reef noise detection range (less than 328 ft. [100.01 m]) (Vermeij et al. 2010). Anthropogenic sounds could mask important acoustic cues, affecting detection of settlement cues or predators, potentially affecting larval settlement patterns or survivability in highly modified acoustic environments (Simpson et al. 2011). Low-frequency sounds could interfere with perception of low-frequency rasps or rumbles among crustaceans, although these are often already obscured by ambient noise (Patek et al. 2009). Sonar is not used in areas where corals proposed for ESA listing are known to occur.

Studies of invertebrate behavioral responses to sound have focused on responses to impulse sound. Some caged squid showed strong startle responses, including inking, when exposed to the first shot of broadband sound from a nearby seismic airgun (sound exposure level of 163 dB re 1 μPa^2-s), but strong startle responses were not seen when sounds were gradually increased (McCauley et al. 2000a, b). Slight increases in behavioral responses, such as jetting away or changes in swim speed, were observed at received levels exceeding 145 dB re 1 μPa^2-s (McCauley et al. 2000a, b). Other studies have shown no observable response by marine invertebrates to sounds. Snow crabs did not react to repeated firings of a seismic airgun (peak received sound level was 201 dB re 1 µPa) (Christian et al. 2003) and squid did not respond to killer whale echolocation clicks (higher frequency signals ranging from 199 to 226 dB re 1 µPa) (Wilson et al. 2007). Krill did not respond to a research vessel approaching at 2.7 knots (source level below 150 dB re 1 µPa) (Brierley et al. 2003). Distraction may be a consequence of some sound exposures. Hermit crabs were shown to delay reaction to an approaching visual threat when exposed to continuous noise, putting them at increased risk of predation (Chan et al. 2010).

There is some evidence of possible stress effects on invertebrates from long-term or intense sound exposure. Captive sand shrimp exposed to low-frequency noise (30 to 40 dB above ambient) continuously for 3 months demonstrated decreases in both growth rate and reproductive rate (Lagardère 1982). Sand shrimp showed lower rates of metabolism when kept in quiet, soundproofed tanks than when kept in tanks with typical ambient noise (Lagardère and Régnault 1980). The effect of long-term (multiple years), intermittent sound exposure was examined in a statistical analysis of recorded catch rate of rock lobster and seismic airgun activity (Parry and Gason 2006). No correlation was found between catch rate and seismic airgun activity, implying no long-term population impacts from intermittent anthropogenic sound exposure over long periods.

Because research on the consequences of exposing marine invertebrates to anthropogenic sounds is limited, qualitative analyses described below were conducted to determine the effects of the following acoustic stressors on marine invertebrates within the Study Area: non-impulse sources (including sonar other active acoustic sources) and impulse acoustic sources (including explosives, swimmer defense airguns, and weapons firing).

3.8.3.1.1 Impacts from Sonar and Other Active Acoustic Sources

Sources of non-impulse underwater sound during testing and training activities include vessel noise (including surface ships, boats, and submarines), aircraft overflight noise (fixed-wing and rotary-wing aircraft), sonar, and other active non-impulse sources.

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 near the Navy port facilities and training areas within the Mariana Islands Range Complex (MIRC). Additionally, a variety of smaller craft could be operated within the Study Area. Surface combatant ships and submarines are designed to be quiet to evade enemy detection. 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.

Fixed and rotary-wing aircraft are used for a variety of training and testing activities throughout the Study Area. Airborne broadband noise from aircraft can be transmitted through the air-water interface, though much of energy is lost at the sea-air interface. Underwater sounds from aircraft are strongest just below the surface and directly under the aircraft. Sonar and other active acoustic sources emit sound waves into the water to detect objects, safely navigate, and communicate. These sources may emit low-, mid-, high-, or very-high-frequency sounds at various sound pressure levels.

Most marine invertebrates do not have the capability to sense sound; however, some may be sensitive to nearby low-frequency and possibly lower-mid-frequency sounds, such as some active acoustic sources or vessel noise (see Section 3.8.2.1, Invertebrate Hearing and Vocalization). Because marine invertebrates lack the adaptations that would allow them to sense sound pressure at long distances, the distance at which they may detect a sound is probably limited.

The relatively low sound pressure level beneath the water surface due to aircraft is likely not detectable by most marine invertebrates. For example, the sound pressure level from an H-60 helicopter hovering at 50 ft. is estimated to be about 125 dB re 1 µPa at 1 m below the surface, a sound pressure lower than other sounds to which marine invertebrates have shown no reaction (see Section 3.8.3.1, Acoustic Stressors). Therefore, impacts due to aircraft overflight noise are not expected.

3.8.3.1.1.1 No Action Alternative

Training Activities

Under the No Action Alternative, marine invertebrates would be exposed to low-, mid-, and high-frequency sonar; vessel noise; and aircraft overflight noise during training activities. These activities could occur throughout the open ocean areas of the Study Area. 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. A more detailed description of these activities, the number of activities, and their proposed locations is provided in Table 2.8-1.

Species that do not occur within these specified areas would not be exposed to low-, mid-, and high-frequency sonar; vessel noise; and aircraft overflight noise during training activities. Species that do occur within the areas listed above—including all 40 proposed ESA-listed species—would have the potential to be exposed to sonar, vessel, and aircraft noise. Human-induced physical damage was considered by NMFS to be a “negligible to low-importance” threat to coral species and was not cited as a factor when considering the ESA listing of coral species.

Corals throughout the Study Area may be exposed to non-impulse sounds generated by sonar and other active acoustic sources, vessels, and aircraft during training. Most underwater acoustic sources would not be used in the shallow waters (less than 100 ft. [30 m]) where proposed ESA-listed species are known to exist. There is no evidence that corals or coral larvae are sensitive to distant non-impulse sounds, although larvae may sense particle motion from close sounds. Sound from training activities is intermittent or transient, or both, and will not commonly occur close enough to reefs to interfere with larval perception of reef noise.

Most marine invertebrates will not sense mid- or high-frequency sounds, but some individual marine invertebrates may sense nearby low-frequency sounds such as vessel noise, aircraft overflight noise (transmitted through the air-water interface), and lower-frequency sonar. Because most non-impulse sound sources are transient or intermittent, or both, any responses are likely to be short-term behavioral responses or brief masking. Non-impulse sounds may impact individual marine invertebrates and groups of marine invertebrates close to a sound source, but they are unlikely to impact populations or subpopulations.

Pursuant to the ESA, sonar and other active acoustic sources associated with training activities as described under the No Action Alternative may affect, but are not likely to adversely affect, any of the coral species currently proposed for ESA listing.

Testing Activities

Under the No Action Alternative, marine invertebrates could be exposed to low-, mid-, and high-frequency acoustic sources used during testing activities. Testing activities potentially using non-impulse acoustic sources under the No Action Alternative include the North Pacific Acoustic Lab Philippine Sea Experiment (Table 2.4-4). Research vessels, acoustic test sources, side scan sonar, ocean gliders, the existing moored acoustic tomographic array and distributed vertical line array, and other oceanographic data collection equipment will be used to collect information on the ocean environment and sound propagation during the 2018 data collection period.

Proposed ESA corals are not expected to be present in the portion of the Study Area where the Philippine Sea Experiment is conducted. Underwater acoustic sources would not be used in the shallow waters (less than 100 ft. [30 m]) where proposed ESA-listed species are known to exist. There is no evidence that corals or coral larvae are sensitive to distant non-impulse sounds. Sound from testing activities is intermittent or transient, or both, and will not commonly occur close enough to reefs to interfere with larval perception of reef noise.

Pursuant to the ESA, sonar and other active acoustic sources associated with testing activities as described under the No Action Alternative may affect, but are not likely to adversely affect, any of the coral species currently proposed for ESA listing.

3.8.3.1.1.2 Alternative 1

Training Activities

Under Alternative 1, marine invertebrates would be exposed to low-, mid-, and high-frequency sonar and other acoustic sources, vessel noise, and aircraft overflight noise during training activities. 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 as indicated in Table 3.0-8 of Chapter 3 (Affected Environment and Environmental Consequences), over the No Action Alternative. However, the vast majority of activities that produce non-impulse sound occur greater than 3 nautical miles (nm) from shore within the Study Area. As the depth of the water drops quickly as you move away from the inshore reefs, the density of benthic invertebrates drops. Invertebrates that are in these locations could be exposed to non-impulse acoustic sources. However, because most non-impulse sound sources would be transient or intermittent, or both, any responses would likely be short-term behavioral responses or brief masking. Non-impulse sounds could impact individual marine invertebrates and groups of marine invertebrates close to a sound source, but they are unlikely to impact populations or subpopulations.

Corals throughout the Study Area may be exposed to non-impulse sounds generated by sonar and other acoustic sources, vessels, and aircraft during training under Alternative 1. However, the vast majority of underwater acoustic sources would not be used in the shallow waters (less than 100 ft. [30 m]) where the majority of proposed ESA-listed species are known to exist. The proposed ESA-listed species that are found in deeper waters may be exposed to non-impulsive sounds, which could impact individual marine invertebrates and groups of marine invertebrates close to the sound source, but they are unlikely to impact populations or subpopulations. Sound from training activities is intermittent or transient, or both, and will not commonly occur close enough to reefs or proposed ESA-listed species to interfere with larval perception of reef noise. Continuous noise from training activities (e.g., vessel noise) could mask reef noise. If this noise source overlapped with the larval settlement period, recruitment of larvae onto a reef habitat may be altered.

Pursuant to the ESA, sonar and other active acoustic sources associated with training activities as described under Alternative 1 may affect, but are not likely to adversely affect, any of the coral species currently proposed for ESA listing.

Testing Activities

Under Alternative 1, marine invertebrates could be exposed to low-, mid-, and high-frequency sonar and other active acoustic sources, vessel noise, and aircraft overflight noise during testing activities. The number of testing activities that produce in-water noise from the use of sonar and other active acoustic sources under Alternative 1 would increase from the No Action Alternative. A detailed description of these activities, the number of activities, and their proposed locations are presented in Tables 2.8-2 to 2.8-4 of Chapter 2 (Description of Proposed Action and Alternatives). Testing activities using sonar and other active acoustic sources would include anti-submarine warfare, lifecycle activities, Ship Signature Testing, Torpedo Testing, Countermeasure Testing, At-Sea Sonar Testing, Pierside Integrated Swimmer Defense, Mine Countermeasure (MCM) Mission Package Testing, and new ship construction testing.

Annual testing activities that produce in-water sound from the use of sonar and other active acoustic sources under Alternative 1 would increase as indicated in Tables 2.8-2 through 2.8-4 and Table 3.0-8 of Chapter 3 (Affected Environment and Environmental Consequences), over no usage under the No Action Alternative. Similarly, aircraft events increase (from 0 under the No Action Alternative, to 320 [Table 3.0-14]) as do activities involving vessels. However, the vast majority of activities that produce non-impulse sound occur greater than 3 nm from shore within the Study Area. As the depth of the water drops quickly as you move away from the inshore reefs, the density of benthic invertebrates drops. Invertebrates that are in these locations could be exposed to non-impulse acoustic sources. However, because most non-impulse sound sources would be transient or intermittent, or both, any responses would likely be short-term behavioral responses or brief masking. Non-impulse sounds could impact individual marine invertebrates and groups of marine invertebrates close to a sound source, but they are unlikely to impact populations or subpopulations.

Corals throughout the Study Area could be exposed to non-impulse sounds generated by sonar and other acoustic sources, vessels, and aircraft during testing. There is no evidence that corals or coral larvae are sensitive to distant non-impulse sounds, although larvae may sense particle motion from close sounds. Sound from testing activities would be intermittent or transient, or both, and would not commonly occur close enough to reefs to interfere with larval perception of reef noise. Non-intermittent noise from testing activities (e.g., vessel noise) could mask reef noise. If this noise source overlapped with the larval settlement period, recruitment of larvae onto a reef habitat may be altered. Explosives and impulse sounds may impact individual marine invertebrates and groups of marine invertebrates, but they are unlikely to impact populations or subpopulations.

Pursuant to the ESA, sonar and other active acoustic sources associated with testing activities as described under Alternative 1 may affect, but are not likely to adversely affect, any of the coral species currently proposed for ESA listing.

3.8.3.1.1.3 Alternative 2

Training Activities

Under Alternative 2, marine invertebrates would be exposed to low-, mid-, and high-frequency sonar and other acoustic sources, vessel noise, and aircraft overflight noise during training activities. The number of annual training activities that produce in-water noise from the use of sonar and other active acoustic sources under Alternative 2 would as indicated in Table 3.0-8 of Chapter 3 (Affected Environment and Environmental Consequences), over Alternative 1. However, the vast majority of activities that produce non-impulse sound occur greater than 3 nm from shore within the Study Area. As the depth of the water drops quickly as you move away from the inshore reefs, the density of benthic invertebrates drops. Invertebrates that are in these locations could be exposed to non-impulse acoustic sources. However, because most non-impulse sound sources would be transient or intermittent, or both, any responses would likely to be short-term behavioral responses or brief masking. Non-impulse sounds could impact individual marine invertebrates and groups of marine invertebrates close to a sound source, but they are unlikely to impact populations or subpopulations. Continuous noise from training activities (e.g., vessel noise) could mask reef noise. If this noise source overlapped with the larval settlement period, recruitment of larvae onto a reef habitat may be altered.

Corals throughout the Study Area may be exposed to non-impulse sounds generated by sonar and other acoustic sources, vessels, and aircraft during training under Alternative 2. However, the vast majority of underwater acoustic sources would not be used in the shallow waters (less than 100 ft. [30 m]) where the majority of the proposed ESA-listed species are known to exist. The proposed ESA-listed species that are found in deeper waters may be exposed to non-impulsive sounds that could impact individual marine invertebrates and groups of marine invertebrates close to the sound source, but they are unlikely to impact populations or subpopulations. Sound from training activities is intermittent or transient, or both, and will not commonly occur close enough to reefs or proposed ESA-listed species to interfere with larval perception of reef noise.

Pursuant to the ESA, sonar and other active acoustic sources associated with training activities as described under Alternative 2 may affect, but are not likely to adversely affect, any of the coral species currently proposed for ESA listing.

Testing Activities

Under Alternative 2, marine invertebrates would be exposed to low-, mid-, and high-frequency sonar and other acoustic sources, vessel noise, and aircraft overflight noise during testing activities. The number of testing activities that produce in-water noise from the use of sonar and other active acoustic sources under Alternative 2 would increase from the No Action Alternative. A detailed description of these activities, the number of activities, and their proposed locations are presented in Tables 2.8-2 to 2.8-4 of Chapter 2 (Description of Proposed Action and Alternatives). Testing activities using sonar and other active acoustic sources would include anti-submarine warfare, lifecycle activities, Ship Signature Testing, Torpedo Testing, Countermeasure Testing, At-Sea Sonar Testing, Pierside Integrated Swimmer Defense, MCM Mission Package Testing, and new ship construction testing.

Annual testing activities that produce in-water noise from the use of sonar and other active acoustic sources under Alternative 2 would increase as indicated in Table 2.8-2 through 2.8-4 and Table 3.0-8 of Chapter 3 (Affected Environment and Environmental Consequences), over no usage under the No Action Alternative. Similarly, aircraft events increase (from 0 under the No Action Alternative, to 362 [Table 3.0-14]) as do activities involving vessels. However, the vast majority of activities that produce non-impulse sound occur greater than 3 nm from shore within the Study Area. As the depth of the water drops quickly as you move away from the inshore reefs, the density of benthic invertebrates drops. Invertebrates that are in these locations could be exposed to non-impulse acoustic sources. However, because most non-impulse sound sources would be transient or intermittent, or both, any responses would likely be short-term behavioral responses or brief masking. Non-impulse sounds could impact individual marine invertebrates and groups of marine invertebrates close to a sound source, but they are unlikely to impact populations or subpopulations.

Corals throughout the Study Area could be exposed to non-impulse sounds generated by sonar and other acoustic sources, vessels, and aircraft during testing. There is no evidence that corals or coral larvae are sensitive to distant non-impulse sounds, although larvae may sense particle motion from close sounds. Sound from testing activities would be intermittent or transient, or both, and would not commonly occur close enough to reefs to interfere with larval perception of reef noise. Non-intermittent noise from testing activities (e.g., vessel noise) could mask reef noise. If this noise source overlapped with the larval settlement period, recruitment of larvae onto a reef habitat may be altered.

Pursuant to the ESA, sonar and other active acoustic sources associated with testing activities as described under Alternative 2 may affect, but are not likely to adversely affect, any of the coral species currently proposed for ESA listing.

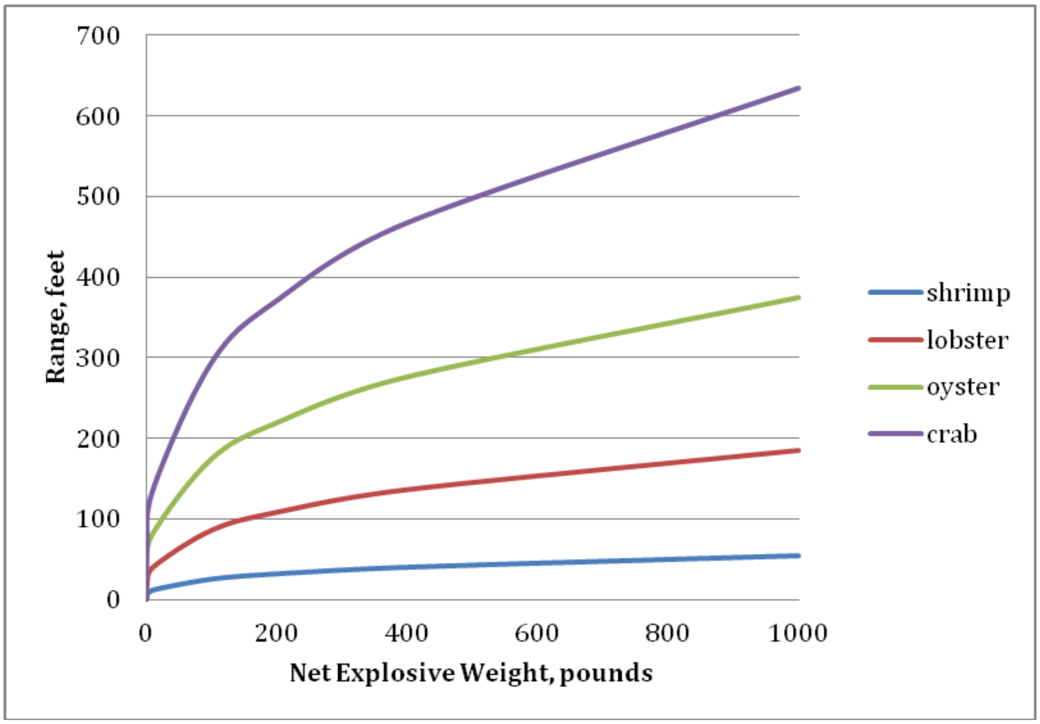
3.8.3.1.1.4 Substressor Impact on Sedentary Invertebrate Beds and Reefs as Essential Fish Habitat (Preferred Alternative)

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of sonar and other active acoustic sources during training and testing activities will have no adverse effect on sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern within the Study Area.

3.8.3.1.2 Impacts from Explosives and Other Impulsive Sources

Explosives, weapons firing, launch, and subsequent impact of ordnance on the water's surface, and swimmer defense airguns introduce loud, impulse, broadband sounds into the marine environment. Impulse sources are characterized by rapid pressure rise times and high peak pressures. Explosions produce high-pressure shock waves that could cause injury or physical disturbance due to rapid pressure changes. Some other impulse sources, such as swimmer defense airguns, also produce shock waves, but of lower intensity. Impulse sounds are usually brief, but the associated rapid pressure changes can injure or startle marine invertebrates.

The few studies of marine invertebrates (crustaceans and molluscs) exposed to explosions show a range of impacts, from mortality close to the source to no observable effects. Limited studies of crustaceans have examined mortality rates at various distances from detonations in shallow water (Chesapeake Biological Laboratory 1948; Gaspin et al. 1976). Similar studies of molluscs have shown them to be more resistant than crustaceans to explosive impacts (Chesapeake Biological Laboratory 1948; Gaspin et al. 1976). Other invertebrates found in association with molluscs, such as sea anemones, polychaete worms, isopods, and amphipods, were observed to be undamaged in areas near detonations (Gaspin et al. 1976). Using data from these experiments, Young (1991) developed curves that estimate the distance from an explosion beyond which at least 90 percent of certain marine invertebrates would survive, depending on the weight of the explosive (Figure 3.8-2). For example, 90 percent of crabs would survive a 200-pound explosion if they are greater than 350 ft. away from the source.



Source: Young 1991

Figure 3.8-2: Prediction of Distance to 90 Percent Survivability of Marine Invertebrates Exposed to an Underwater Explosion

In deeper waters (most detonations would occur near the water surface), most benthic marine invertebrates would be beyond the 90 percent survivability ranges shown above, even for larger quantities of explosives. Some charges detonated in shallow water or near the seafloor could kill and injure marine invertebrates on or near the seafloor depending on the species and the distance to the underwater explosion. A blast in the vicinity of hard corals could cause direct impact to coral polyps, or fragmentation and siltation of the corals; in one study, recovery from a single small blast directly on a reef took 5 to 10 years (Fox and Caldwell 2006). A blast near the bottom could also disturb hard substrate suitable for colonization.

Marine invertebrate mortalities and direct traumas caused by underwater and surface explosions are more likely to occur in the water column than on the bottom in deeper waters because most detonations would occur at or near the water surface. The number of organisms affected would depend on the size of the explosive, the distance from the explosion, the exact geographic location in the Study Area, and the presence invertebrates. In addition to trauma caused by a shock wave, organisms could be killed in an area of cavitation that forms near the surface above a large underwater detonation. Cavitation is where the reflected shock wave creates a region of negative pressure followed by a collapse, or water hammer.

Airguns have slower rise times and lower peak pressures than many explosives. Studies of airgun impacts on marine invertebrates have used seismic airguns, which are more powerful than any swimmer defense airguns proposed for use during Navy testing. Studies of crustaceans have shown that adult crustaceans were not noticeably physically affected by exposures to intense seismic airgun use (Christian et al. 2003; Payne et al. 2007). Snow crab eggs repeatedly exposed to airgun firings had slightly increased mortality and apparent delayed development (Christian et al. 2003), but Dungeness crab (*Metacarcinus magister*) zoeae were not affected by repeated exposures (Pearson et al. 1993). Some squid showed strong startle responses, including inking, when exposed to the first shot of broadband sound from a nearby seismic airgun (sound exposure level of 163 dB re 1 μPa^2-s), but strong startle responses were not seen when sounds were gradually increased (McCauley et al. 2000a, b). Airguns used during testing of swimmer defense systems are intended to be nonlethal swimmer deterrents, and are substantially less powerful than those used in seismic studies. It is unlikely that they would injure marine invertebrates as the swimmer defense airguns would be used only in Navy ports (Inner Apra Harbor), which does not support large marine invertebrate communities and as such, are not carried forward in the analysis.

Firing weapons on a ship generates sound from firing the gun (muzzle blast), from the shell flying through the air, and from the blast vibrating through the ship's hull. A blast wave from a gun fired above the surface of the water propagates away from the gun muzzle into the water. In addition, larger non-explosive munitions and targets could produce loud impulsive noise when hitting the water, depending on the size, weight, and speed of the object at impact. Small- and medium-caliber munitions are not expected to produce substantial impact noise.

Based on studies with airguns, some marine invertebrates exposed to impulsive sounds from swimmer defense airguns and weapons firing may exhibit startle reactions, such as inking by a squid or changes in swim speed. Similarly, marine invertebrates beyond the range to any injurious effects from exposure to explosions may also exhibit startle reactions. Repetitive impulses during multiple explosions, such as during a firing exercise, may be more likely to have injurious effects or cause avoidance reactions. However, impulsive sounds produced in water during testing and training are single impulses or multiple impulses over a limited duration (e.g., gun firing or driving a pile). Any auditory masking, in which the sound of an impulse could prevent detection of other biologically relevant sounds, would be very brief.

At a distance, impulses lose their high pressure peak and take on characteristics of non-impulsive acoustic waves. Similar to the impacts expected for non-impulsive sounds discussed previously, it is expected these exposures would cause no more than brief startle reactions in some marine invertebrates.

3.8.3.1.2.1 No Action Alternative

Training Activities

Under the No Action Alternative, marine invertebrates would be exposed to explosions and underwater impulse sounds from weapons firing, launch, and non-explosive impacts during training activities. Weapons firing, launch, and non-explosive impacts would be spread throughout the Study Area;

explosions would occur during naval gunnery, missile exercises, bombing exercises, sinking exercises, tracking exercises, and mine warfare. The largest source class used during training under the No Action Alternative would be E12 (650 to 1,000 pound [lb.] net explosive weight [NEW]) (295 to 454 kilograms [kg] NEW) (Table 3.0-9). However, of all explosives used for training under the No Action Alternative (1,594), only four are of this source class, and this source class is only used in the Study Area at distances greater than 50 nm from shore. The vast majority of all explosives used under the No Action Alternative (approximately 84 percent) occur in areas greater than 12 nm from shore.

Under the No Action Alternative, training activities using explosions that could occur anywhere in the Study Area, including within the Mariana littoral zones (nearshore shallow areas below the high tide line), are restricted to 50 detonations annually, all of them less than at or below the E5 source class (5–10 lb. [2.3–4.5 kg] NEW). Based on Young (1991), some charges detonated in shallow water or near the seafloor associated with mine neutralization activities could kill and injure marine invertebrates on or near the seafloor in the immediate vicinity of the detonation, though due to the low source class used, the zone of potential impact would be quite small. A blast in the vicinity of hard corals could cause fragmentation and siltation of the corals; in one study, recovery from a single small blast directly on a reef took 5 to 10 years (Fox and Caldwell 2006). A blast near the bottom could also disturb hard substrate suitable for colonization. However, as described in Section 3.3 (Marine Habitats), coral reefs and associated higher productivity areas do not overlap with the mine neutralization areas. It is not expected that a large number of pelagic invertebrates would be present in the area of these activities.

In general, explosive activities would consist of a single explosion or a few smaller explosions over a short period. Some marine invertebrates close to a detonation would likely be killed or injured. Weapons firing, launch, and non-explosive impacts would consist of a single pulse or several impulses over a short period. In general, marine invertebrates are unlikely to respond to sounds from detonations or weapons firing, launch, or impact noise unless they are very close to the sound source. Some marine invertebrates may be sensitive to the low-frequency component of impulse sound, and they may exhibit startle reactions or temporary changes in swim speed. Because the exposures are brief, limited in number, and spread over a large area, no long-term impacts are expected. Explosives and impulse sounds may impact individual marine invertebrates and groups of marine invertebrates, but they are unlikely to impact populations or subpopulations.

The vast majority of all explosives used under the No Action Alternative occur in areas greater than 12 nm from shore, which are not known to support coral species proposed for listing. However, if corals are present in areas overlapping with training activities using explosives, shallow-water, hardbottom, and deep-water corals could be impacted by explosions. Explosive impacts on the benthic invertebrates are more likely when an explosive is large compared to the water depth or when an explosive is detonated at or near the bottom and would include fragmentation and/or siltation. Consequences of exposure to an explosive shock wave could include breakage, injury, or mortality. Many corals and hardbottom invertebrates are sessile, fragile, and particularly vulnerable. Many of these organisms grow slowly, and could require decades to recover (Precht et al. 2001). Because most detonations occur in deeper waters near the water surface, most corals and other benthic invertebrates would not experience intense shock wave impacts.

The large number of possible explosions could alter the benthic community as mortality on hard corals could be substantial, and with continued exercises there would be no time for recovery. This would have impacts at sites where explosions are conducted in nearshore areas. However, training activities that include bottom-laid underwater explosions are infrequent (only about 50 explosions per year), and the percentage of training area affected is small (less than 1 percent of the total Study Area). Additionally, detonations occur in the same area, Agat Bay Mine Neutralization Site and Outer Apra Harbor Underwater Detonation (UNDET) sites, which are located in waters that are not known to support large invertebrate communities, which further reduces the potential for population level impacts.

Pursuant to the ESA, explosions and underwater impulsive sound generated during training activities as described under the No Action Alternative may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

Testing Activities

Under the No Action Alternative, there are no testing activities that involve explosive detonations or other impulse sources.

3.8.3.1.2.2 Alternative 1

Training Activities

Under Alternative 1, the number of explosives used during training activities would rise to 10,006 per year. Similar to the No Action Alternative, marine invertebrates would be exposed to explosions and underwater impulse sounds from weapons firing, launch, and non-explosive impacts during training activities. Weapons firing, launch, and non-explosive impacts would be spread throughout the Study Area; explosions would occur during naval gunnery, missile exercises, bombing exercises, sinking exercises, tracking exercises, and mine warfare. Approximately 94 percent of the explosions would occur in areas greater than 12 nm from shore.

The total number of explosive detonations that could occur in the shallow portions of the Study Area where corals and high productivity areas exist would increase from 50 to 94. Similar to the No Action Alternative, the source class for these activities is E5 (5 to 10 lb. [2.3 to 4.5 kg] NEW) or less. The additional detonations (either E2 [0.26 to 0.5 lb. {0.12 to 0.23 kg} NEW] or E5) in all training areas (but potentially in shallow waters) would increase the disturbance of benthic invertebrates, relative to the No Action Alternative. Shallow-water, hardbottom, and deep-water corals could be impacted by explosions. No explosions would occur in areas known to support coral species proposed for listing.

The vast majority of all explosives used under Alternative 1 occur in areas greater than 12 nm from shore, which are not known to support listed coral species. However, if corals are present in areas overlapping with training activities using explosives, shallow-water, hardbottom, and deep-water corals could be impacted by explosions. Under Alternative 1, Agat Bay Mine Neutralization Site and Outer Apra Harbor UNDET sites change the size of underwater detonations from 10 lb. to 20 lb. NEW. The Piti Point Mine Neutralization site remains at 10 lb. NEW. Consequences of exposure to an explosive shock wave could include breakage, injury, or mortality. Many corals and hardbottom invertebrates are sessile, fragile, and particularly vulnerable. Many of these organisms grow slowly and could require decades to recover (Precht et al. 2001). If the sites of the explosions are the same for the nearshore exercises, this could over time (years) alter the benthic composition of especially sessile invertebrates (e.g., coral). Population-level impacts in the near shore areas could be possible depending on the size of the impacted areas, however, training activities that include bottom-laid underwater explosions are infrequent (only about 50 explosions per year), and the percentage of training area affected is small (less than 1 percent of the total Study Area). Additionally, detonations occur in the same area, Agat Bay Mine Neutralization Site and Outer Apra Harbor UNDET sites, which are located in waters that are not known to support large invertebrate communities, which further reduces the potential for population level impacts.

The remaining activities conducted under Alternative 1 utilizing explosive detonations would be restricted to portions of the Study Area that are greater than 12 nm from the shore. Based on Young (1991), some charges could kill and injure marine invertebrates in the immediate vicinity of the detonation, though due to the low source class used, the zone of potential impact would be quite small. Given the large area where training activities occur, and the lack of shallow water habitat greater than 2 nm away from shorelines, explosives and impulse sounds may impact individual marine invertebrates and groups of marine invertebrates, but they are unlikely to impact populations or subpopulations.

Pursuant to the ESA, explosions and underwater impulsive sound generated during training activities as described under Alternative 1 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

Testing Activities

Alternative 1 would introduce testing activities that would involve the use of 6,805 high-explosives. As presented in Tables 2.8-2 to 2.8-4, these testing activities occur in waters greater than 3 nm from shore within the MIRC, which are not known to support listed coral species. However, if corals are present in areas overlapping with testing activities using explosives, shallow-water corals, hardbottom, and deep-water corals could be impacted by explosions. Consequences of exposure to an explosive shock wave could include breakage, injury, or mortality. Many corals and hardbottom invertebrates are sessile, fragile, and particularly vulnerable. Many of these organisms grow slowly and could require decades to recover (Precht et al. 2001).

Based on Young (1991), some charges could kill and injure marine invertebrates in the immediate vicinity of the detonation. Some marine invertebrates may be sensitive to the low-frequency component of impulse sound, and they may exhibit startle reactions or temporary changes in swim speed. However, because the exposures are brief, limited in number, and spread over a large area, no long-term impacts are expected. Explosives and impulsive sounds may impact individual marine invertebrates and groups of marine invertebrates, but they are unlikely to impact populations or subpopulations.

Pursuant to the ESA, explosions and underwater impulsive sound generated during testing activities as described under Alternative 1 may affect, but are not likely to adversely affect, coral species currently proposed for ESA listing.

3.8.3.1.2.3 Alternative 2

Training Activities

Under Alternative 2, the number of explosives used during training activities would rise from 1,594 to 10,284 per year, as compared to the No Action Alternative. Similar to the No Action Alternative, marine invertebrates would be exposed to explosions and underwater impulse sounds from weapons firing, launch, and non-explosive impacts during training activities. Weapons firing, launch, and non-explosive impacts would be spread throughout the Study Area; explosions would occur during naval gunnery, missile exercises, bombing exercises, sinking exercises, tracking exercises, and mine warfare.

The vast majority (approximately 94 percent) of all explosives used under Alternative 2 occur in areas greater than 12 nm from shore, which are not known to support listed coral species. However, if corals are present in areas overlapping with training activities using explosives, shallow-water corals, hardbottom, and deep-water corals could be impacted by explosions. Under Alternative 2, Agat Bay Mine Neutralization Site and Outer Apra Harbor UNDET sites change the size of underwater detonations from 10 lb. to 20 lb. NEW. The Piti Point Mine Neutralization site remains at 10 lb. NEW. Consequences of exposure to an explosive shock wave could include breakage, injury, or mortality.

The total number of explosive detonations that could occur in the shallow portions of the Study Area where corals and high productivity areas exist would increase. Similar to the No Action Alternative, the source class for these activities is E5 (5 to 10 lb. [2.3 to 4.5 kg] NEW) or less. The additional detonations (either E2 [0.26 to 0.5 lb. {0.12 to 0.23 kg} NEW] or E5) in all training areas (but potentially in shallow waters) would increase the disturbance of benthic invertebrates, relative to the No Action Alternative.

If a proposed ESA-listed species (or any other coral species) were to occur in areas used during training activities, consequences of exposure to an explosive shock wave could include breakage, injury, or mortality. Many corals and hardbottom invertebrates are sessile, fragile, and particularly vulnerable. Many of these organisms grow slowly and could require decades to recover (Precht et al. 2001). If the sites of the explosions are the same for the nearshore exercises, this could over time (years) alter the benthic composition of especially sessile invertebrates (e.g., coral). Population-level impacts in the near shore areas could be possible depending on the size of the impacted areas. However, training activities that include bottom-laid underwater explosions are infrequent (only about 50 explosions per year), and the percentage of training area affected is small (less than 1 percent of the total Study Area). Additionally, detonations occur in the same area, Agat Bay Mine Neutralization Site and Outer Apra Harbor UNDET sites, which are located in waters that are not known to support large invertebrate communities, which further reduces the potential for population level impacts.

The remaining activities conducted under Alternative 2 utilizing explosive detonations would be restricted to portions of the Study Area that are greater than 12 nm from the shore. Over 9,710 detonations could occur, and 98 percent of these detonations would be restricted to source class E6 (10 to 20 lb. [4.5 to 9.1 kg] NEW) or less (Table 3.0-9). Based on Young (1991), some charges could kill and injure marine invertebrates in the immediate vicinity of the detonation, though due to the low source class used, the zone of potential impact would be quite small. Given the large area where training activities occur, and the lack of shallow water habitat greater than 2 nm away from shorelines, explosives and impulse sounds may impact individual marine invertebrates and groups of marine invertebrates (including pelagic larvae).

Pursuant to the ESA, explosions and underwater impulsive sound generated during training activities as described under Alternative 2 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

Testing Activities

Alternative 2 would introduce testing activities that would involve the use of 8,335 high-explosives, all of which could occur throughout the Study Area, although the majority occur in waters greater than 3 nm from shore within the MIRC. Because these detonations occur in deeper waters near the water surface, most corals and other benthic invertebrates would not experience intense shock wave impacts. If a proposed ESA-listed coral (or any other coral species) were to occur in areas used during testing activities, consequences of exposure to an explosive shock wave could include breakage, injury, or mortality. Many corals and hardbottom invertebrates are sessile, fragile, and particularly vulnerable. Many of these organisms grow slowly, and could require decades to recover (Precht et al. 2001).

Based on Young (1991), some explosive charges could kill and injure marine invertebrates in the immediate vicinity of the detonation. Some marine invertebrates may be sensitive to the low-frequency component of impulse sound, and they may exhibit startle reactions or temporary changes in swim speed. However, because the exposures are brief, limited in number, and spread over a large area, no long-term impacts are expected. Explosives and impulsive sounds may impact individual marine invertebrates and groups of marine invertebrates, but they are unlikely to impact populations or subpopulations.

Pursuant to the ESA, explosions and underwater impulsive sound generated during testing activities as described under Alternative 2 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

3.8.3.1.2.4 Substressor Impact on Sedentary Invertebrate Beds and Reefs as Essential Fish Habitat (Preferred Alternative)

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of explosives and other impulsive sources during training and testing activities may have an adverse effect on EFH by reducing the quality or quantity of sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern (U.S. Department of the Navy 2013). The use of other impulsive sources (swimmer defense airguns; and weapons firing, launch, and impact noise) during training and testing activities will not have an adverse effect on EFH by reducing the quality or quantity of sedentary invertebrate beds or offshore reefs that constitute EFH or Habitat Areas of Particular Concern within the Study Area.

3.8.3.1.3 Summary of Impacts from Acoustic Stressors

Most testing and training activities would generate underwater impulse or non-impulse sounds from some combination of several sources, including sonar, other active acoustic sources, vessels, aircraft, explosions, airguns, weapons firing, weapons launches, or non-explosive impacts. Both pelagic and benthic marine invertebrates could be impacted by these stressors. In most cases, marine invertebrates would not respond to impulse and non-impulse sounds, although they may detect and briefly respond to nearby low-frequency sounds. These short-term responses would likely be inconsequential. Explosions would likely kill or injure nearby marine invertebrates. Explosions near the seafloor and very large explosions in the water column may impact shallow water corals, hardbottom habitat and associated marine invertebrates, and deep-water corals, including physical disturbance, fragmentation, or mortality (both to sessile organisms and pelagic larvae). Most explosions at the water surface would not injure benthic marine invertebrates because the explosive weights would be small compared to the water depth. Additionally, the vast majority of explosions occur at distances greater than 3 nm from shore, in water depths greater than those for shallow water coral species.

3.8.3.2 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 electromagnetic devices.

3.8.3.2.1 Impacts from Electromagnetic Devices

Several different types of electromagnetic devices are used during training and testing activities. 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, please 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 Appendix H, Section H.3 (Conceptual Framework for Assessing Effects from Energy-Producing Activities).

Little information exists about marine invertebrates' susceptibility to electromagnetic fields. Most corals are thought to use water temperature, day length, lunar cycles, and tidal fluctuations as cues for spawning. Magnetic fields are not known to control coral spawning release or larval settlement. Some arthropods (e.g., spiny lobster and American lobster) can sense magnetic fields, and this ability is thought to assist the animal with navigation and orientation (Lohmann et al. 1995; Normandeau et al. 2011). These animals travel relatively long distances during their lives, and magnetic field sensation may exist in other invertebrates that travel long distances. Marine invertebrates, including several commercially important species and federally managed species, could use magnetic cues (Normandeau et al. 2011). Susceptibility experiments have focused on arthropods, but several mollusks and echinoderms are also susceptible. However, because susceptibility is variable within taxonomic groups it is not possible to make generalized predictions for groups of marine invertebrates. Sensitivity thresholds vary by species ranging from 0.3 to 30 milliteslas, and responses included non-lethal physiological and behavioral changes (Normandeau et al. 2011). The primary use of magnetic cues seems to be navigation and orientation. Human-introduced electromagnetic fields could disrupt these cues and interfere with navigation, orientation, or migration. Because electromagnetic fields weaken exponentially with increasing distance from their source, large and sustained magnetic fields present greater exposure risks than small and transient fields, even if the small field is many times stronger than the earth's magnetic field (Normandeau et al. 2011). Transient or moving electromagnetic fields may cause temporary disturbance to susceptible organisms' navigation and orientation.

3.8.3.2.1.1 No Action Alternative

Training Activities

Under the No Action Alternative, there are no training activities that involve the use of electromagnetic devices.

Testing Activities

Under the No Action Alternative, there are no testing activities that involve the use of electromagnetic devices.

3.8.3.2.1.2 Alternative 1

Training Activities

As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), training activities involving electromagnetic devices under Alternative 1 occur up to five times annually as part of MCM (towed mine detection) and Civilian Port Defense activities. Table 2.8-1 lists the number and location of training activities that use electromagnetic devices. Little information exists about marine invertebrates' susceptibility to electromagnetic fields. Most corals are thought to use water temperature, day length, lunar cycles, and tidal fluctuations as cues for spawning. Magnetic fields are not known to control coral spawning release or larval settlement.

The impact of electromagnetic fields on marine invertebrates would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges; (2) the number of activities involving the stressor is low; (3) exposures would be localized, temporary, and would cease with the conclusion of the activity; and (4) even for susceptible organisms invertebrates (e.g., some species of arthropods, mollusks, and echinoderms) the consequences of exposure are limited to temporary disruptions to navigation and orientation.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under Alternative 1 would have no effect on coral species currently proposed for ESA listing.

Testing Activities

Mine countermeasure mission package testing for new ship systems includes the use of electromagnetic devices (radar systems and magnetic fields generated underwater to detect mines). Under Alternative 1, the Naval Sea Systems Command will engage in up to 32 MCM mission package testing activities annually.

The impact of electromagnetic fields on marine invertebrates would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges; (2) the number of activities involving the stressor is low; (3) exposures would be localized, temporary, and would cease with the conclusion of the activity; and (4) even for susceptible organisms invertebrates (e.g., some species of arthropods, mollusks, and echinoderms) the consequences of exposure are limited to temporary disruptions to navigation and orientation.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under Alternative 1 would have no effect on coral species currently proposed for ESA listing.

3.8.3.2.1.3 Alternative 2

Training Activities

As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), training activities involving electromagnetic devices under Alternative 2 occur up to five times annually as part of MCM (towed mine detection) and Civilian Port Defense activities. Table 2.8-1 lists the number and location of training activities that use electromagnetic devices.

The impact of electromagnetic fields on marine invertebrates would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges; (2) the number of activities involving the stressor is low; (3) exposures would be localized, temporary, and would cease with the conclusion of the activity; and (4) even for susceptible organisms invertebrates (e.g., some species of arthropods, mollusks, and echinoderms) the consequences of exposure are limited to temporary disruptions to navigation and orientation.

Pursuant to the ESA, the use of electromagnetic devices during training activities as described under Alternative 2 would have no effect on coral species currently proposed for ESA listing.

Testing Activities

Mine countermeasure mission package testing for new ship systems includes the use of electromagnetic devices (radar systems and magnetic fields generated underwater to detect mines). Under Alternative 2, the Naval Sea Systems Command will engage in up to 36 MCM mission package testing activities annually.

The impact of electromagnetic fields on marine invertebrates would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges; (2) the number of activities involving the stressor is low; (3) exposures would be localized, temporary, and would cease with the conclusion of the activity; and (4) even for susceptible organisms invertebrates (e.g., some species of arthropods, mollusks, and echinoderms) the consequences of exposure are limited to temporary disruptions to navigation and orientation.

Pursuant to the ESA, the use of electromagnetic devices during testing activities as described under Alternative 2 would have no effect on coral species currently proposed for ESA listing.

3.8.3.2.1.4 Substressor Impacts on Sedentary Invertebrate Beds or Reefs as Essential Fish Habitat

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of electromagnetic devices during training and testing activities will have minimal and temporary adverse effects on invertebrates that occupy water column EFH or Habitat Areas of Particular Concern, and will have no adverse effect on sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern within the Study Area.

3.8.3.3 Physical Disturbance and Strike Stressors

This section analyzes the potential impacts of the various types of physical disturbance and strike stressors caused by Navy training and testing activities within the Study Area. For a list of locations and numbers of activities that may cause physical disturbance and strikes refer to Section 3.0.5.3.3 (Physical Disturbance and Strike Stressors). The physical disturbance and strike stressors that may impact marine invertebrates include (1) vessels and in-water devices, (2) military expended materials, and (3) seafloor devices.

Most marine invertebrate populations extend across wide areas containing hundreds or thousands of discrete patches of suitable habitat. Sessile (attached to the seafloor or other surface) invertebrate populations may be maintained by complex currents that carry adults and young from place to place. Such widespread populations are difficult to evaluate in terms of Navy training and testing activities that occur intermittently and in relatively small patches in the Study Area. Even invertebrate populations that are somewhat restricted in range, such as coral reefs, cover enormous areas (see Section 3.3, Marine Habitats, for quantitative assessments). In this context, a physical strike or disturbance would impact individual organisms directly or indirectly.

With few exceptions, activities involving vessels and in-water devices are not intended to contact the seafloor. Except for amphibious activities and bottom-crawling unmanned underwater vehicles, there is minimal potential strike impact and limited potential disturbance impact on benthic or habitat-forming marine invertebrates.

With the exception of corals and other sessile benthic invertebrates, most mobile invertebrate populations recover quickly from non-extractive disturbance. Other invertebrates, such as the small soft-bodied organisms that live in the bottom sediment, are thought to be well-adapted to natural physical disturbances, although recovery from human-induced disturbance is delayed by decades or more (Kaiser et al. 2002; Lindholm et al. 2011). Biogenic habitats such as coral reefs, deep coral, and sponge communities may take decades to re-grow following a strike or disturbance (Jennings and Kaiser 1998; Precht et al. 2001). If the sites of the activities are the same for repeated exercises, this could over time (years) alter the benthic composition, especially sessile invertebrates (e.g., coral).

3.8.3.3.1 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 (such as remotely operated vehicles, unmanned surface vehicles and unmanned undersea vehicles, and towed devices). Vessels and in-water devices could impact marine invertebrates by disturbing the water column or sediments, or directly striking organisms (Bishop 2008). The propeller wash (water displaced by propellers used for propulsion) from vessel movement and water displaced from vessel hulls could disturb marine invertebrates in the water column, and is a likely cause of zooplankton mortality (Bickel et al. 2011). This local and short-term exposure to vessel and propeller movements could displace, injure, or kill zooplankton, invertebrate eggs or larvae, and macro-invertebrates in the upper portions of the water column.

Few sources of information are available on the impact of non-lethal chronic disturbance on marine invertebrates. One study of seagrass-associated marine invertebrates found that chronic disturbance from vessel wakes resulted in the long-term displacement of some marine invertebrates from the impacted shallow-water area (Bishop 2008). Impacts of this type resulting from repeated exposure in shallow water are not likely to result from Navy training and testing activities because (1) most vessel movements occur in relatively deep water, and (2) vessel movements are concentrated in well-established port facilities and associated channels (Mintz and Parker 2006).

Vessels and towed in-water devices do not normally collide with invertebrates that inhabit the seafloor because Navy vessels are operated in relatively deep waters and have navigational capabilities to avoid contact with these habitats. A consequence of vessel operation in shallow water is increased turbidity from stirring-up bottom sediments. Turbidity can impact corals and invertebrate communities on hardbottom areas by reducing the amount of light that reaches these organisms and by increasing the energy the organism expends on sediment removal (Riegl and Branch 1995). Reef-building corals are sensitive to water clarity because of their symbiotic algae (i.e., zooxanthellae) that require sunlight to live. Encrusting organisms residing on hardbottom can be impacted by persistent silting from increased turbidity. In addition, propeller wash and physical contact with coral and hardbottom areas can cause structural damage to the substrate, as well as mortality to encrusting organisms. While information on the frequency of vessel operations in shallow water is not adequate to support a specific risk assessment, typical navigational procedures minimize the likelihood of contacting the seafloor, and most Navy vessel movements in nearshore waters are confined to established channels and ports, or predictable transit lanes to adjoining training areas through deep water.

Unmanned underwater vehicles travel at relatively low speeds, and are smaller than most vessels, making the risk of strike or physical disturbance to marine invertebrates very low. Zooplankton, invertebrate eggs or larvae, and macro-invertebrates in the water column could be displaced, injured, or killed by unmanned underwater vehicle movements.

3.8.3.3.1.1 No Action Alternative

Training Activities

As indicated above, the majority of the training activities under all alternatives involve vessels, and a few of the activities involve the use of in-water devices. These activities could be widely dispersed throughout the Study Area, but would be more concentrated near naval ports, piers, and range areas. Large, slow vessels would pose little risk to marine invertebrates in the open ocean although, in coastal waters, currents from large vessels may cause resuspension and settlement of sediment onto sensitive invertebrate communities. Fast boats would generally pose more of a risk through propeller action in shallow waters. Exposure of marine invertebrates to vessel disturbance and strikes would be limited to organisms in the water column, and primarily in the uppermost portions of the water column. Most pelagic marine invertebrates are disturbed as the water flows around the vessel, towed in-water device, or autonomous vehicle. Injury or mortality caused directly or indirectly by propellers is possible, but the scale of impacts would be limited, and population-level impacts are unlikely. Under the No Action Alternative, these shallow-water vessels would continue to operate in defined boat lanes with sufficient depths to avoid propeller or hull strikes of benthic invertebrates on the seafloor, thereby minimizing impacts to invertebrate populations.

Amphibious Assault and Amphibious Raids could occur up to four and two times annually, respectively. These could occur at beaches at Una Babui, Una Chulu, and Unai Dankulo on Tinian and can also occur at Dry Dock Island in Apra Harbor, Dadi Beach on Guam. Benthic invertebrates of the surf zone, such as crabs, clams, and polychaete worms, within the disturbed area could be displaced, injured, or killed during amphibious operations. As is current practice, exposure of coral and other hard bottom habitats would be avoided in the No Action Alternative. Prior to any Amphibious Assaults and Amphibious Raids with larger amphibious vehicles, a pre-landing surveillance of the area would be undertaken to identify the best landing route, which would help avoid identified obstacles. Surveys would not be necessary for beach landings with small boats, such as Rigid Hull Inflatable Boats (RHIBs).

Based on the pre-landing surveillance, if the landing area/lane is clear, the activity could be conducted, and crews would follow procedures to avoid obstructions to navigation, including coral reefs. The Navy would conduct separate consultations as appropriate before conducting the activity.

Benthic invertebrates within the disturbed area, such as crabs, clams, and polychaete worms, could be displaced, injured, or killed during amphibious operations. Benthic invertebrates inhabiting these areas are adapted to a highly variable environment and are expected to rapidly re-colonize disturbed areas by immigration and larval recruitment. Studies indicate that benthic communities of high-energy sandy beaches recover relatively quickly (typically within 2 to 7 months) following beach nourishment (U.S. Army Corps of Engineers 2001). Schoeman et al. (2000) found that the macrobenthic (visible organisms on the seafloor) community required between 7 and 16 days to recover following excavation and removal of sand from a 2,153 $ft.^2$ (200 m^2) quadrant in the mid-intertidal zone of a sandy beach.

Exposure of marine invertebrates to vessel disturbance and strikes would be limited to organisms in the water column (primarily in the uppermost portions of the water column) and organisms occupying shallow water habitats. Most pelagic marine invertebrates are disturbed as the water flows around the vessel, towed in-water device, or autonomous vehicle. A consequence of vessel operation in shallow water is increased turbidity from stirring-up bottom sediments as well as the potential for running aground. Turbidity can impact corals and invertebrate communities in shallow water areas by reducing the amount of light that reaches these organisms and by increasing the effort the organism expends on sediment removal (Riegl and Branch 1995). Reef-building corals are sensitive to water clarity because of their symbiotic algae (i.e., zooxanthellae) that require sunlight to live. Encrusting organisms residing on hardbottom can be impacted by persistent silting from increased turbidity. In addition, propeller wash and physical contact with coral and hardbottom areas can cause structural damage to the substrate, as well as mortality to encrusting organisms. Injury or mortality caused directly or indirectly by propellers or vessels is possible, but the scale of impacts would be limited, and population-level impacts are unlikely.

The impact of vessels and in-water devices on marine invertebrates would be inconsequential because: (1) the area exposed to the stressor amounts to a small portion of each vessel's and in-water device's footprint, and is extremely small relative to most marine invertebrates' ranges; (2) the frequency of activities involving the stressor is low such that few individuals could be exposed to more than one event; and (3) exposures would be localized, temporary, and would cease with the conclusion of the activity. Activities involving vessels and in-water devices are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, vessel or in-water device strikes or physical disturbance from training activities as described under the No Action Alternative may affect, but are not likely to adversely affect, proposed ESA-listed coral species.

Testing Activities

Under the No Action Alternative, there are no testing activities except for vessels transiting to the North Pacific Acoustic Lab Philippine Sea Experiment site. Exposure of marine invertebrates to vessel disturbances and strikes would be limited to organisms in the water column, and primarily in the uppermost portions of the water column. Most pelagic marine invertebrates are disturbed as the water flows around the vessel, towed in-water device, or autonomous vehicle. Injury or mortality caused directly or indirectly by propellers is possible, but the scale of impacts would be limited, and population-level impacts are unlikely.

Pursuant to the ESA, vessel or in-water device strikes or physical disturbance from testing activities as described under the No Action Alternative would have no effect on coral species currently proposed for ESA listing.

3.8.3.3.1.2 Alternative 1

Training Activities

As described in Section 2.7.3.2 (Vessels), additional ships are proposed under Alternative 1 as well as increase in overall vessel use in the Study Area. The replacement of the Nimitz Class aircraft carriers would introduce new aircraft carriers into the activities described in this EIS/OEIS. The first replacement Gerald Ford Class aircraft carrier is expected to be operational within the MITT Study Area in 2015. The replacement of Nimitz Class aircraft carriers would not increase the potential for marine invertebrate disturbance because there would be no net increase of aircraft carriers within the Study Area, the operational differences between Nimitz and Gerald Ford Classes are minor, and no new training activities would result from the introduction of Gerald Ford Class aircraft carriers.

Under Alternative 1, the Navy plans to introduce a new class of destroyers (Zumwalt Class, Multi-Mission Destroyers), which would require increased training exercises relative to existing destroyer class ships. Although the increase in training would increase the potential for disturbance of marine invertebrates, the impacts of the Zumwalt Class destroyers during training and testing activities would not differ from those of existing destroyers. Therefore, the likelihood of disturbance would increase not because of the new destroyer class, but because of increased vessel movements under Alternative 1. However, as described above, vessels do not normally collide with invertebrates because Navy vessels are operated in relatively deep waters and also have navigational capabilities to avoid contact with benthic habitats.

Alternative 1 also proposes to introduce new vessels (not replacement class vessel for existing vessels). The Littoral Combat Ship, the Joint High Speed Vessel, and the Expeditionary Fighting Vehicle are all fast vessels that may operate in nearshore waters. These areas typically support marine invertebrates within the water column and benthic habitats, so the potential for disturbance or strike of marine invertebrates in nearshore waters would increase.

In addition to manned ships, the Navy also proposes to introduce unmanned undersea and surface systems under Alternative 1. These devices can operate anywhere from the water surface to the benthic zone. Certain devices do not have a realistic potential to strike living marine resources because they either move slowly through the water column (e.g., most unmanned undersurface vehicles) or are closely monitored by observers manning the towing platform (e.g., most towed devices). Even at low speeds, however, zooplankton, invertebrate eggs or larvae, corals, and macro-invertebrates in the water column could be displaced, injured, or killed by unmanned underwater vehicle movements. Consequences of exposure of corals to an unmanned undersea and surface system could include breakage, injury, or mortality.

Because of their size and potential operating speed, in-water devices that operate in a manner with the potential to strike living marine resources are the Unmanned Surface Vehicles. All of the vehicles described in Section 2.7.3.3 (Unmanned Vehicles and Systems) use advanced propeller systems with encased propellers to prevent damage to sea beds (seafloor fauna, such as corals and other invertebrate species). The Sea Maverick Unmanned Surface System operates in harbors and bays; therefore, it could increase the risk of interactions with marine invertebrates. A consequence of vessel operation in shallow water is increased turbidity from stirring-up bottom sediments. Bottom sediments would be disturbed, and localized increases in turbidity would occur when an in-water device makes contact with the seafloor, but turbidity would quickly dissipate (i.e., time scales of minutes to hours) following the exercise. Training activities that involve the use of unmanned surface or underwater activities include Amphibious Raid activities (Table 2.8-1), which occur six times a year.

Amphibious Assault and Amphibious Raids could occur up to six times each annually. These could occur at beaches at Una Babui, Una Chulu, and Unai Dankulo on Tinian and can also occur at Dry Dock Island in Apra Harbor, Dadi Beach on Guam. Benthic invertebrates of the surf zone, such as crabs, clams, and polychaete worms, within the disturbed area could be displaced, injured, or killed during amphibious operations. As is current practice, exposure of coral and other hard bottom habitats would continue to be avoided in the Proposed Action. Prior to any Amphibious Assaults and Amphibious Raids with larger amphibious vehicles, a pre-landing surveillance of the area would be undertaken to identify the best landing route, which would help avoid identified obstacles. Surveys would not be necessary for beach landings with small boats, such as RHIBs.

Based on the pre-landing surveillance, if the landing area/lane is clear, the activity could be conducted, and crews would follow procedures to avoid obstructions to navigation, including coral reefs. The Navy would conduct separate consultations as appropriate before conducting the activity.

Benthic invertebrates within the disturbed area, such as crabs, clams, and polychaete worms, could be displaced, injured, or killed during amphibious operations. Benthic invertebrates inhabiting these areas are adapted to a highly variable environment and are expected to rapidly re-colonize disturbed areas by immigration and larval recruitment. Studies indicate that benthic communities of high-energy sandy beaches recover relatively quickly (typically within 2 to 7 months) following beach nourishment (U.S. Army Corps of Engineers 2001). Schoeman et al. (2000) found that the macrobenthic (visible organisms on the seafloor) community required between 7 and 16 days to recover following excavation and removal of sand from a 2,153 $ft.^2$ (200 m^2) quadrant in the mid-intertidal zone of a sandy beach.

Exposure of marine invertebrates to vessel disturbance and strikes would be limited to organisms in the water column (primarily in the uppermost portions of the water column) and organisms occupying shallow water habitats. Species that do not occur near the surface within the Study Area—including proposed for ESA-listing coral—would not be exposed to vessel strikes. Most pelagic marine invertebrates are disturbed as the water flows around the vessel, towed in-water device, or autonomous vehicle. A consequence of vessel operation in shallow water is increased turbidity from stirring-up bottom sediments as well as the potential for running aground. Turbidity can impact corals and invertebrate communities in shallow water areas by reducing the amount of light that reaches these organisms and by increasing the effort the organism expends on sediment removal (Riegl and Branch 1995). Reef-building corals are sensitive to water clarity because of their symbiotic algae (i.e., zooxanthellae) that require sunlight to live. Encrusting organisms residing on hardbottom can be impacted by persistent silting from increased turbidity. In addition, propeller wash and physical contact with coral and hardbottom areas can cause structural damage to the substrate, as well as mortality to encrusting organisms. Injury or mortality caused directly or indirectly by propellers or vessels is possible, but the scale of impacts would be limited, and population-level impacts are unlikely.

The impact of vessels and in-water devices on marine invertebrates would be inconsequential because: (1) the area exposed to the stressor amounts to a small portion of each vessel's and in-water device's footprint, and is extremely small relative to most marine invertebrates' ranges; (2) the frequency of activities involving the stressor is low such that few individuals could be exposed to more than one event; and (3) exposures would be localized, temporary, and would cease with the conclusion of the activity. Activities involving vessels and in-water devices are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, vessel or in-water device strikes or physical disturbance from training activities as described under the Alternative 1 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

Testing Activities

Alternative 1 would introduce new testing activities into the Study Area involving ships and underwater vehicle types. Exposure of marine invertebrates to vessel disturbance and strikes would be limited to organisms in the water column, and primarily in the uppermost portions of the water column. Species that do not occur near the surface within the Study Area—including proposed for ESA-listing coral—would not be exposed to vessel strikes. Most pelagic marine invertebrates are disturbed as the water flows around the vessel, towed in-water device, or autonomous vehicle. Injury or mortality caused directly or indirectly by propellers is possible, but the scale of impacts would be limited, and population-level impacts are unlikely.

The impact of vessels and in-water devices on marine invertebrates would be inconsequential because: (1) the area exposed to the stressor amounts to a small portion of each vessel's and in-water device's footprint, and is extremely small relative to most marine invertebrates' ranges; (2) the frequency of activities involving the stressor is low such that few individuals could be exposed to more than one event; and (3) exposures would be localized, temporary, and would cease with the conclusion of the activity. Activities involving vessels and in-water devices are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, vessel or in-water device strikes or physical disturbance from testing activities as described under Alternative 1 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

3.8.3.3.1.3 Alternative 2

Training Activities

As described for Alternative 1, Alternative 2 includes the same new ship classes and vessels and activity numbers. Exposure of marine invertebrates to vessel disturbance and strikes would be limited to organisms in the water column (primarily in the uppermost portions of the water column) and organisms occupying shallow water habitats. Species that do not occur near the surface within the Study Area—including proposed for ESA-listing coral—would not be exposed to vessel strikes. Injury or mortality caused directly or indirectly by propellers or vessels is possible, but the scale of impacts would be limited, and population-level impacts are unlikely.

Amphibious Assault and Amphibious Raids could occur up to six times each annually. These could occur at beaches at Una Babui, Una Chulu, and Unai Dankulo on Tinian and can also occur at Dry Dock Island in Apra Harbor, Dadi Beach on Guam. Benthic invertebrates of the surf zone, such as crabs, clams, and polychaete worms, within the disturbed area could be displaced, injured, or killed during amphibious operations. As is current practice, exposure of coral and other hard bottom habitats would continue to be avoided in the Proposed Action. Prior to any Amphibious Assaults and Amphibious Raids with larger amphibious vehicles, a pre-landing surveillance of the area would be undertaken to identify the best landing route, which would help avoid identified obstacles. Surveys would not be necessary for beach landings with small boats, such as RHIBs.

Based on the pre-landing surveillance, if the landing area/lane is clear, the activity could be conducted, and crews would follow procedures to avoid obstructions to navigation, including coral reefs. The Navy would conduct separate consultations as appropriate before conducting the activity.

The impact of vessels and in-water devices on marine invertebrates would be inconsequential because: (1) the area exposed to the stressor amounts to a small portion of each vessel's and in-water device's footprint, and is extremely small relative to most marine invertebrates' ranges; (2) the frequency of activities involving the stressor is low such that few individuals could be exposed to more than one event; and (3) exposures would be localized, temporary, and would cease with the conclusion of the activity. Activities involving vessels and in-water devices are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, vessel or in-water device strikes or physical disturbance from training activities as described under the Alternative 2 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

Testing Activities

Alternative 2 would include an incremental increase above Alternative 1 testing activities and an increase of test and trial activities. Exposure of marine invertebrates to vessel disturbance and strikes would be limited to organisms in the water column, and primarily in the uppermost portions of the water column. Species that do not occur near the surface within the Study Area—including proposed for ESA-listing coral—would not be exposed to vessel strikes. Most pelagic marine invertebrates are disturbed as the water flows around the vessel, towed in-water device, or autonomous vehicle. Injury or mortality caused directly or indirectly by propellers is possible, but the scale of impacts would be limited, and population-level impacts are unlikely. Seafloor invertebrates, including coral species currently proposed for ESA-listing, are not likely to be exposed to this sub-stressor.

The impact of vessels and in-water devices on marine invertebrates would be inconsequential because: (1) the area exposed to the stressor amounts to a small portion of each vessel's and in-water device's footprint, and is extremely small relative to most marine invertebrates' ranges; (2) the frequency of activities involving the stressor is low such that few individuals could be exposed to more than one event; and (3) exposures would be localized, temporary, and would cease with the conclusion of the activity. Activities involving vessels and in-water devices are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, vessel or in-water device strikes or physical disturbance from testing activities as described under Alternative 2 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

3.8.3.3.1.4 Substressor Impact on Sedentary Invertebrate Beds and Reefs as Essential Fish Habitat (Preferred Alternative)

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of vessels and in-water devices during training and testing activities will have no effect on sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern within the Study Area.

3.8.3.3.2 Impacts from Military Expended Materials

This section analyzes the strike potential to marine invertebrates 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 ordnance, 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 Materials).

The spatial extent of military expended materials deposition includes all of the Study Area. Despite this broad range, the majority of military expended materials deposition occurs within established range complexes and testing ranges. These areas of higher military expended materials deposition are generally away from the coastline.

Chaff and flares include canisters, end-caps, and aluminum-coated glass fibers. Chaff, in particular, may be transported great distances by the wind, beyond the areas where they are deployed before contacting the sea surface. These materials contact the sea surface and seafloor with very little kinetic energy, and their low buoyant weight makes them an inconsequential strike and abrasion risk. Aerial countermeasures, therefore, will not be addressed as potential strike and disturbance stressors.

Physical disturbance or strikes by military expended materials on marine invertebrates is possible at the water's surface, through the water column, and at the seafloor. Disturbance or strike impacts on marine invertebrates by military expended materials falling through the water column is possible but not very likely because their kinetic energy dissipates within a few feet of the sea surface and they do not generally sink rapidly enough to cause strike injury. Exposed invertebrates would likely experience only temporary displacement as the object passes by. Therefore, the discussion of military expended materials disturbance and strikes will focus on military expended materials on the water's surface and the seafloor.

Sessile marine invertebrates and infauna are susceptible to military expended material strikes, particularly shallow-water corals, hardbottom, and deep-water corals. Most shallow-water coral reefs in the Study Area are within or adjacent to land masses, where expended materials are primarily lightweight flares and chaff, which have inconsequential strike potential.

3.8.3.3.2.1 Military Expended Materials that are Ordnance

Small-, Medium-, and Large-Caliber Projectiles

Various types of projectiles could cause a temporary local impact when they strike the surface of the water. Navy training and testing in the Study Area, such as gunnery exercises, include firing a variety of weapons and using a variety of non-explosive training and testing rounds, including and small-, medium, and large-caliber projectiles. With the exception of terrestrial based activities at Farallon De Medinilla, the larger-caliber projectiles are primarily used in the open ocean beyond 12 nm from shore.

Direct ordnance strikes from firing weapons are potential strike stressors to marine invertebrates. Military expended materials have the potential to impact the water with great force. Physical disruption of the water column is a localized, temporary impact and would be limited to within tens of meters of the impact area, persisting for a matter of minutes. Physical and chemical properties of the surrounding water would be temporarily altered (e.g., slight heating or cooling and increased oxygen concentrations due to turbulent mixing with the atmosphere), but there would be no lasting change resulting in long-term impacts on marine invertebrates. Although the sea surface is rich with invertebrates, most are zooplankton and relatively few are large pelagic invertebrates (e.g., some jellyfish and some swimming crabs). Zooplankton, eggs and larvae, and larger pelagic organisms in the upper portions of the water column could be displaced, injured, or killed by military expended materials impacting the sea surface. Individual organisms would be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted, primarily because the number of organisms exposed to these devices is extremely small relative to population sizes.

Marine invertebrate communities and individuals at various stages of development (eggs, larvae, or adults) would be exposed to munitions, including small-, medium-, and large-caliber projectiles. Marine invertebrates on the seafloor could be displaced, injured, or killed by military expended materials contacting the seafloor.

Potential impacts of projectiles on marine invertebrates, including shallow-water, hardbottom, or deep-water corals, present the greatest risk of long-term damage compared with other seafloor communities because (1) many corals and hardbottom invertebrates are sessile, fragile, and particularly vulnerable; (2) many of these organisms grow slowly, and could require decades to recover (Precht et al. 2001); and (3) military expended materials are likely to remain mobile for a longer period because natural encrusting and burial processes are much slower on these habitats than on hardbottom habitats.

Bombs, Missiles, and Rockets

Bombs, missiles, and rockets are potential strike stressors to marine invertebrates. The nature of their potential impacts is the same as projectiles. However, they are addressed separately because they are larger than most projectiles, and because high-explosive bombs, missiles, and rockets are likely to produce a greater number of small fragments than projectiles. Propelled fragments are produced by high explosives. Close to the explosive, invertebrates could be injured by propelled fragments. However, studies of underwater bomb blasts have shown that fragments are larger than those produced during air blasts and decelerate much more rapidly (O'Keefe and Young 1984; Swisdak Jr. and Montaro 1992), reducing the risk to marine organisms. Bombs, missiles, and rockets are designed to explode within 3 ft.

(1.01 m) of the sea surface where invertebrates are relatively infrequent. The fitness of individual organisms would be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted, primarily because the number of organisms exposed to these devices would be extremely small relative to population sizes.

3.8.3.3.2.2 Military Expended Materials Other than Ordnance

Vessel Hulk

During a sinking exercise, aircraft, ship, and submarine crews deliver ordnance on a surface target, which is a clean (Section 3.1, Sediments and Water Quality) deactivated ship that is deliberately sunk using multiple weapon systems. Sinking exercises occur in specific open ocean areas, outside of the coastal range complexes. Ordnance strikes by the various weapons used in these exercises are a potential source of impacts. However, these impacts are discussed for each of those weapons categories in this section and are not repeated here. Therefore, the analysis of sinking exercises as a strike potential for benthic invertebrates is discussed in terms of the ship hulk landing on the seafloor. The primary difference between a vessel hulk and other military expended materials as a strike potential for marine invertebrates is a difference in scale. As the vessel hulk settles on the seafloor, all marine invertebrates within the footprint of the hulk would be impacted by strike or burial, and invertebrates a short distance beyond the footprint of the hulk would be disturbed. A deposited vessel hulk will potentially change local flow patterns, which could impact food delivery, patterns of sediment deposition and erosion, patterns of predation based on halo effects of predators around the vessel, and community changes based on new hard substratum high in the flow field off the seafloor. Habitat-forming invertebrates are likely absent where sinking exercises are planned because this activity occurs in depths greater than the range of corals and most other habitat-forming invertebrates (approximately 10,000 ft. [3,048 m]). It is possible that deep-sea corals may be impacted by a sinking vessel hulk or fragments of a hulk, but the size of the impact on the seafloor relative to the relatively broad distribution of deep sea corals suggests that these impacts would seldom occur.

Decelerators/Parachutes

Decelerators/Parachutes of varying sizes are used during training and testing activities. Sonobuoys, lightweight torpedoes, anti-submarine warfare training targets, and other devices deployed by aircraft use nylon decelerators/parachutes of various sizes. Decelerators/parachutes are made of cloth and nylon, and many have weights attached to the lines for rapid sinking. At water impact, the decelerator/parachute assembly is expended, and it sinks away from the unit. The decelerator/parachute assembly may remain at the surface for 5–15 seconds before the decelerator/parachute and its housing sink to the seafloor, where it becomes flattened (Section 3.0.5.3.4.2, Decelerators/Parachutes). Activities that expend sonobuoys and air-launched torpedo parachutes generally occur in water deeper than 183 m (600.4 ft.). Because they are in the air and water column for a time span of minutes, it is improbable that such a decelerator/parachute deployed over water deeper than 183 m (600.4 ft.) could travel far enough to affect shallow-water corals, including proposed for ESA-listing coral species. Movement of the decelerator/parachute in the water may break more fragile invertebrates such as deep-water corals.

3.8.3.3.2.3 No Action Alternative

Training Activities

Under the No Action Alternative, several different types of military expended materials with a potential for striking marine invertebrates are expended in the at-sea portion of the Study Area, as grouped below (Tables 3.0-18 and 3.0-19):

- **Bombs:** Under the No Action Alternative, 32 high-explosive bombs and 522 non-explosive bombs would be expended during training activities. These bombs would be expended in areas greater than 50 nm from shore.
- **Small-caliber projectiles:** Under the No Action Alternative, 60,000 small-caliber projectiles would be expended during training activities. These small-caliber projectiles would be expended throughout the Study Area.
- **Medium-caliber projectiles:** Under the No Action Alternative, 26,500 non-explosive, medium-caliber projectiles would be expended during training activities. These medium-caliber projectiles would be expended in areas greater than 3 nm from shore within the Study Area.
- **Large-caliber projectiles:** Under the No Action Alternative, 1,240 high-explosive, large-caliber projectiles would be expended during training activities. These large-caliber projectiles would be expended in areas greater than 12 nm from shore within the Study Area.
- **Missiles:** Under the No Action Alternative, 58 high-explosive missiles would be expended during training activities. These missiles would be expended in areas greater than 12 nm from shore within the Study Area.
- **Decelerators/parachutes:** Under the No Action Alternative, 8,032 decelerators/parachutes would be expended during training activities. Decelerators/parachutes would be expended in the following locations in areas greater than 3 nm from shore throughout the Study Area.

Bombs, missiles, rockets, projectiles, and associated fragments may strike marine invertebrates, including zooplankton, eggs, and larvae, at the sea surface or on the seafloor. Consequences of strike or disturbance could include injury or mortality, particularly within the footprint of the object as it contacts the seafloor. Individual organisms could be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted, primarily because the number of organisms exposed to these devices is extremely small relative to population sizes. The exceptions to this are corals (potentially including proposed coral species), which would be susceptible to abrasion injury, breakage, or mortality from fragments striking or settling upon the coral. Because these organisms are habitat-forming and also constitute some habitat areas of particular concern, these same impacts could degrade habitat quality. Individual organisms would be impacted directly or indirectly to the extent that the viability of populations or species would be impacted. However, as indicated in Chapter 2 (Description of Proposed Action and Alternatives), projectiles are used greater than 3 nm from the shore, and typically greater than 12 nm from shore, within the Study Area. At these distances from shore, the overlap between the area potentially impacted and areas containing coral habitat is extremely low.

During sinking exercises, pelagic invertebrates present near the water's surface in the immediate vicinity of the exercise could potentially be injured or killed. Sinking exercise vessel hulks contacting the seafloor would result in mortality of marine invertebrates within the footprint of the hulk and disturbance of marine invertebrates near the footprint of the hulk. Sinking exercises may result in injury or mortality of marine invertebrates near the footprint of the hulk. Though the footprint of a sinking exercise is large relative to other military expended materials, the impacted area is extremely small relative to the spatial distribution of marine invertebrate populations as the location of a sinking exercise would not overlap with known coral habitats. Consequences of sinking exercises would impact individual organisms directly or indirectly, but not to the extent that the viability of populations or species would be measurably impacted.

Activities occurring at depths less than 2,600 ft. (800 m) may impact deep-water corals and other marine invertebrate assemblages. Consequences may include breakage, injury, or mortality as a result of projectiles or munitions (see Section 3.3, Marine Habitats). Decelerators/parachutes may cause abrasion injury or mortality, or breakage. Because these organisms are habitat-forming and also constitute some habitat areas of particular concern, these same impacts could degrade habitat quality. Individual organisms would be impacted directly or indirectly to the extent that the viability of populations or species would be impacted.

The impact of military expended materials on marine invertebrates is likely to cause injury or mortality to individuals, but impacts to populations would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one event, and (3) exposures would be localized and would cease when the military expended material stops moving. Activities involving military expended material are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level. However, the combined consequences of all military expended materials could degrade habitat quality.

Pursuant to the ESA, military expended materials strikes associated with training activities as described under the No Action Alternative may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

Testing Activities

Under the No Action Alternative, no military expended materials are deposited in the Study Area from testing activities.

3.8.3.3.2.4 Alternative 1

Training Activities

Under Alternative 1, several different types of military expended materials with a potential for striking marine invertebrates would be expended in the Study Area (see Tables 2.8-1 through 2.8-4 and Table 3.0-18 and 3.0-19 for additional detail), as grouped below:

- **Bombs:** Under Alternative 1, 212 high-explosive bombs and 848 non-explosive bombs would be expended during training activities. These bombs would be expended in areas greater than 12 nm from shore.
- **Small-caliber projectiles:** Under the Alternative 1, 86,140 small-caliber projectiles would be expended during training activities. These small-caliber projectiles would be expended in areas greater than 3 nm from shore within the Study Area.
- **Medium-caliber projectiles:** Under the Alternative 1, 83,500 non-explosive, medium-caliber projectiles and 8,250 high-explosive, medium-caliber projectiles would be expended during training activities. These medium-caliber projectiles would be expended in areas greater than 3 nm from shore within the Study Area.
- **Large-caliber projectiles:** Under Alternative 1, 1,300 high-explosive, large-caliber projectiles and 5,238 non-explosive large-caliber projectiles would be expended during training activities. These large-caliber projectiles would be expended in areas greater than 12 nm from shore within the Study Area.
- **Missiles:** Under the Alternative 1, 113 high-explosive missiles would be expended during training activities. These missiles would be expended in areas greater than 12 nm from shore within the Study Area.

- **Rockets:** Under the Alternative 1, 114 high-explosive rockets would be expended during training activities. These missiles would be expended in areas greater than 12 nm from shore within the Study Area.
- **Decelerators/parachutes:** Under Alternative 1, 10,845 decelerators/parachutes would be expended. Decelerators/parachutes associated would be expended in areas greater than 3 nm from shore throughout the Study Area.

Alternative 1 would include multi-fold increases in small- and medium-caliber projectiles. Bombs, missiles, rockets, projectiles, and associated fragments could strike zooplankton, eggs, or larvae at the sea surface or on the seafloor. Consequences of strike or disturbance could include injury or mortality, particularly within the footprint of the object as it contacts the seafloor. Individual organisms could be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted, primarily because the number of organisms exposed to these devices is extremely small relative to population sizes. Additionally, as indicated in Chapter 2 (Description of Proposed Action and Alternatives), projectiles are used greater than 3 nm from the shore, and typically greater than 12 nm from shore, within the Study Area. At these distances from shore, the overlap between the area potentially impacted and areas containing coral habitat is extremely low.

Sinking exercises may result in injury or mortality of marine invertebrates near the footprint of the hulk. Though the footprint of a sinking exercise is large relative to other military expended materials, the impacted area is extremely small relative to the spatial distribution of marine invertebrate populations. Consequences of sinking exercises would impact individual organisms directly or indirectly, but not to the extent that the viability of populations or species would be measurably impacted.

Activities occurring at depths less than 2,600 ft. (800 m) may impact deep-water corals and other marine invertebrate assemblages. Consequences may include breakage, injury, or mortality as a result of projectiles or munitions. Decelerators/parachutes may cause abrasion injury or mortality, or breakage. Because these organisms are habitat-forming and also constitute some habitat areas of particular concern, these same impacts could degrade habitat quality. Individual organisms would be impacted directly or indirectly to the extent that the viability of populations or species would be impacted.

Although the number of military expended materials would increase under Alternative 1 compared to the No Action Alternative, the types of impacts would be similar to those described under the No Action Alternative. The probability of military expended material strikes on marine invertebrates, however, would increase because of the increase in the number of military expended materials. Activities involving military expended materials are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level. However, the combined consequences of all military expended materials could degrade habitat quality.

Pursuant to the ESA, military expended material strikes associated with training activities as described under Alternative 1 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

Testing Activities

Under Alternative 1, 2,000 small caliber rounds, 2,040 non-explosive medium caliber rounds, 3,680 non-explosive large caliber rounds, 20 non-explosive missiles, and 1,727 decelerators/parachutes would be used during testing activities and those items would be expended in areas greater than 3 nm from shore in the Study Area. Approximately 6,805 high explosives would be used for testing activities under

Alternative 1 (2,040 explosive medium caliber rounds, 3,920 in-air explosive large caliber rounds, 20 explosive missiles, 8 explosive torpedoes, 793 explosive sonobuoys). Missiles, rockets, projectiles, and associated fragments could strike zooplankton, eggs, or larvae at the sea surface or on the seafloor. Consequences of strike or disturbance could include injury or mortality, particularly within the footprint of the object as it contacts the seafloor. Individual organisms could be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted, primarily because the number of organisms exposed to these devices is extremely small relative to population sizes. As indicated in Chapter 2 (Description of Proposed Action and Alternatives), projectiles are used greater than 3 nm from the shore, and typically greater than 12 nm from shore, within the Study Area. At these distances from shore, the overlap between the area potentially impacted and areas containing proposed ESA-listed coral species is extremely low.

Consequences of strikes or disturbances could include injury or mortality, particularly within the footprint of the object as it contacts the seafloor. The fitness (ability to produce offspring) of individual organisms would be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted, primarily because the number of organisms exposed to these devices would be extremely small relative to population sizes.

Although the number of military expended materials would increase under Alternative 1 compared to the No Action Alternative, the types of impacts would be similar to those described under the No Action Alternative. The probability of military expended material strikes on marine invertebrates, however, would increase because of the increase in the number of military expended materials. Activities involving military expended materials are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level. However, the combined consequences of all military expended materials could degrade habitat quality.

Pursuant to the ESA, military expended material strikes associated with testing activities as described under Alternative 1 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

3.8.3.3.2.5 Alternative 2

Training Activities

Under Alternative 2, the Navy proposes the same numbers and types of military expended materials as described in Alternative 1 with the exception of non-explosive medium-caliber projectiles, targets, rockets (explosive), and missiles, which will increase from Alternative 1 to 85,750, 426, 380, and 125 (explosive), respectively (Table 3.0-18 and 3.0-19). With only slight increases from those of Alternative 1, the impacts of Alternative 2 training activities on marine invertebrates would be the same as for Alternative 1.

Pursuant to the ESA, military expended material strikes associated with training activities as described under Alternative 2 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

Testing Activities

Under Alternative 2, 2,500 small caliber rounds, 2,490 non-explosive medium-caliber rounds, 4,300 non-explosive large-caliber rounds, 25 non-explosive missiles, and 1,912 decelerators/parachutes would be used during testing activities, and those items would be expended in areas greater than 3 nm from shore in the Study Area. Approximately 2,490 explosive medium caliber rounds, 4,900 in-air explosive large caliber rounds, 25 explosive missiles, 8 explosive torpedoes, and 884 explosive sonobuoys would be used for testing activities under Alternative 2. Missiles, rockets, projectiles, and associated fragments could strike zooplankton, eggs, or larvae at the sea surface or on the seafloor. Consequences of strike or disturbance could include injury or mortality, particularly within the footprint of the object as it contacts the seafloor. Individual organisms could be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted, primarily because the number of organisms exposed to these devices is extremely small relative to population sizes. As indicated in Chapter 2 (Description of Proposed Action and Alternatives), projectiles are used greater than 3 nm from the shore, and typically greater than 12 nm from shore, within the Study Area. At these distances from shore, the overlap between the area potentially impacted and areas containing proposed ESA-listed coral species is extremely low.

Consequences of strikes or disturbances could include injury or mortality, particularly within the footprint of the object as it contacts the seafloor. The fitness (ability to produce offspring) of individual organisms would be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted, primarily because the number of organisms exposed to these devices would be extremely small relative to population sizes.

Although the number of military expended materials would increase under Alternative 1 compared to the No Action Alternative, the types of impacts would be similar to those described under the No Action Alternative. The probability of military expended material strikes on marine invertebrates, however, would increase because of the increase in the number of military expended materials. Activities involving military expended materials are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction of invertebrate species at the population level. However, the combined consequences of all military expended materials could degrade habitat quality.

Pursuant to the ESA, military expended material strikes associated with testing activities as described under Alternative 2 may affect, but are not likely to adversely affect coral species currently proposed for ESA listing.

3.8.3.3.2.6 Substressor Impact on Sedentary Invertebrate Beds and Reefs as Essential Fish Habitat (Preferred Alternative)

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of military expended materials during training and testing activities may have an adverse effect on EFH by reducing the quality or quantity of sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern. The EFHA states that the impact to sedentary invertebrate beds would be minimal and long-term to permanent in duration (based on substrate impacts), whereas impacts to reefs would be individually minimal and permanent in duration within the Study Area.

3.8.3.3.3 Impacts from Seafloor Devices

Seafloor devices include items that are placed on, dropped on, or moved along, the seafloor, such as mine shapes, anchor blocks or anchors (such as those associated with the Portable Undersea Training Range [PUTR]) that are placed on the substrate for a specific purpose. Deployment of seafloor devices would cause disturbance, injury, or mortality within the footprint of the device, may disturb marine invertebrates outside the footprint of the device, and would cause temporary local increases in turbidity near the ocean bottom. Objects placed on the seafloor may attract invertebrates, or provide temporary attachment points for invertebrates. Some invertebrates attached to the devices would be removed from the habitat when the devices are recovered. A shallow depression may remain in the soft bottom sediment where an anchor was dropped.

3.8.3.3.3.1 No Action Alternative

Training Activities

Table 3.0-21 presents the number and types of training activities involving seafloor devices. Under the No Action Alternative, 44 events involving seafloor devices occur annually. These events are related to mine warfare and PUTR activities. These involve the placement of up to 480 mine shapes on the sea floor within Warning Area-517 and placement of anchor blocks within the MITT Study Area, respectively. The impact of seafloor devices on marine invertebrates is likely to cause injury or mortality to individuals, but impacts to populations would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, and (3) exposures would be localized. Activities involving seafloor devices are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, physical disturbance and strikes by seafloor devices associated with training activities as described under the No Action Alternative would have no effect on coral species currently proposed for ESA listing.

Testing Activities

Under the No Action Alternative, seafloor devices are only utilized during testing activities at the North Pacific Acoustic Lab's Deep Water site. The deep water experimental site (>1,000 m deep [>3,281 ft.]) consists of an acoustic tomography array, a distributed vertical line array, and moorings in the deep-water environment of the northwestern Philippine Sea, which is not known to support shallow-water corals. The impact of seafloor devices on marine invertebrates is likely to cause injury or mortality to individuals, but impacts to populations would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, and (2) the activities and subsequent exposures would be localized. Activities involving seafloor devices associated with testing activities are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, physical disturbance and strikes by seafloor devices associated with testing activities as described under the no Action Alternative would have no effect on coral species currently proposed for ESA listing.

3.8.3.3.3.2 Alternative 1

Training Activities

Table 3.0-21 presents the number and types of training activities involving seafloor devices. Under the Alternative 1, 136 events involving seafloor devices occur annually. Sea floor items include moored mine shapes, anchors, bottom placed instruments, and robotic vehicles referred to as "crawlers," which are typically placed in soft-bottom areas that do not overlap with areas that support coral species. Seafloor devices are either stationary or move very slowly along the bottom and do not pose a threat to highly mobile organisms. The impact of seafloor devices on marine invertebrates is likely to cause injury or mortality to individuals, but impacts to populations would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, and (3) exposures would be localized. Activities involving seafloor devices are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, physical disturbance and strikes by seafloor devices associated with training activities as described under Alternative 1 would have no effect on coral species currently proposed for ESA listing.

Testing Activities

Under Alternative 1, seafloor devices are utilized during pierside integrated swimmer defense activities within Apra Harbor, MCM mission package testing, and testing activities at the North Pacific Acoustic Lab's Deep Water site. Both sites are located in areas that are not known to support shallow-water coral species, the first being a highly disturbed area, and the second being a deep water site. The deep water experimental site consists of an acoustic tomography array, a distributed vertical line array, and moorings in the deep-water environment (depths greater than 3,280 ft. [1,000 m]) of the northwestern Philippine Sea.

The impact of seafloor devices on marine invertebrates could cause injury or mortality to individuals, but impacts to populations would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one event, and (3) the activities and subsequent exposures would be localized. Activities involving seafloor devices associated with testing activities are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, physical disturbance and strikes by seafloor devices associated with testing activities as described under Alternative 1 would have no effect on coral species currently proposed for ESA listing.

3.8.3.3.3.3 Alternative 2

Training Activities

Table 3.0-21 presents the number and types of training activities involving seafloor devices. Under the Alternative 2, 136 events involving seafloor devices occur annually. Sea floor items include moored mine shapes, anchors, bottom placed instruments, and robotic vehicles referred to as "crawlers," which are typically placed in soft-bottom areas that do not overlap with areas that support coral species. Seafloor devices are either stationary or move very slowly along the bottom and do not pose a threat to highly mobile organisms. The impact of seafloor devices on marine invertebrates is likely to cause injury or mortality to individuals, but impacts to populations would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, and (3) exposures would be localized. Activities involving seafloor devices are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, physical disturbance and strikes by seafloor devices associated with training activities as described under Alternative 2 would have no effect on coral species currently proposed for ESA listing.

Testing Activities

Under Alternative 2, seafloor devices are utilized during pierside integrated swimmer defense activities within Apra Harbor, MCM mission package testing, and testing activities at the North Pacific Acoustic Lab's Deep Water site. Both sites are located in areas that are not known to support shallow-water coral species, the first being a highly disturbed area, and the second being a deep water site. The deep water experimental site consists of an acoustic tomography array, a distributed vertical line array, and moorings in the deep-water environment (depths greater than 3,280 ft. [1,000 m]) of the northwestern Philippine Sea.

The impact of seafloor devices on marine invertebrates could cause injury or mortality to individuals, but impacts to populations would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one event, and (3) the activities and subsequent exposures would be localized. Activities involving seafloor devices associated with testing activities are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at the population level.

Pursuant to the ESA, physical disturbance and strikes by seafloor devices associated with testing activities as described under Alternative 2 would have no effect on coral species currently proposed for ESA listing.

3.8.3.3.3.4 Substressor Impact on Sedentary Invertebrate Beds and Reefs as Essential Fish Habitat (Preferred Alternative)

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of seafloor devices during training and testing activities could have an adverse effect on sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern. The EFHA states that the impact to sedentary invertebrate beds (e.g., amphipod tubes, bryozoans) may be minimal and long-term.

3.8.3.4 Entanglement Stressors

This section analyzes the potential entanglement impacts of the various types of expended materials used by the Navy during training and testing activities within the Study Area. Included are potential impacts from two types of military expended materials: (1) fiber optic cables and guidance wires, and (2) decelerators/parachutes. Aspects of entanglement stressors that are applicable to marine organisms in general are presented in Section 3.0.5.3.4 (Entanglement Stressors).

Most marine invertebrates are less susceptible to entanglement than fishes, sea turtles, and marine mammals due to their size, behavior, and morphology. Because even fishing nets, which are designed to take marine invertebrates, operate by enclosing rather than entangling, marine invertebrates seem to be somewhat less susceptible than vertebrates to entanglement (Chuenpagdee et al. 2003; Morgan and Chuenpagdee 2003). A survey of marine debris entanglements found that marine invertebrates composed 16 percent of all animal entanglements (Ocean Conservancy 2010). The same survey cites potential entanglement in military items only in the context of waste-handling aboard ships, and not for military expended materials. Nevertheless, it is conceivable that marine invertebrates, particularly arthropods and echinoderms with rigid appendages, might become entangled in fiber optic cables and guidance wires and in decelerators/parachutes.

3.8.3.4.1 Impacts from Fiber Optic Cables and Guidance Wires

Fiber optic cables are only expended during airborne mine neutralization testing activities and torpedo guidance wires are used in training and testing activities involving heavyweight torpedoes. For a discussion of the types of activities that use guidance wires and fiber optic cables, physical characteristics of these expended materials, where they are used, and how many activities would occur under each alternative, please see Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires). Abrasion and shading-related impacts on sessile benthic (attached to the seafloor) marine invertebrates that may result from entanglement stressors are discussed with physical impacts in Section 3.8.3.3 (Physical Disturbance and Strike Stressors).

A marine invertebrate that might become entangled could be only temporarily confused and escape unharmed, it could be held tightly enough that it could be injured during its struggle to escape, it could be preyed upon while entangled, or it could starve while entangled. The likelihood of these outcomes cannot be predicted with any certainty because interactions between invertebrate species and entanglement hazards are not well known. The potential entanglement scenarios are based on observations of how marine invertebrates are entangled in marine debris, which is far more prone to tangling than guidance wire or fiber optic cable (Environmental Sciences Group 2005; Ocean Conservancy 2010). The small number of guidance wires and fiber optic cables expended across the Study Area results in an extremely low rate of potential encounter for marine invertebrates.

3.8.3.4.1.1 No Action Alternative

<u>Training Activities</u>

As indicated in Table 2.8-1, under the No Action Alternative, torpedoes expending guidance wire would occur in throughout the Study Area during tracking exercises, all greater than 3 nm from the shore. Only 53 torpedoes and torpedo accessories would be used under the No Action Alternative (Table 3.0-18 and Table 3.0-19), and only heavyweight torpedoes utilize guidance wires (40; Table 3.0-24). Due to the location of the activities, only pelagic and deep water benthic invertebrates could be exposed to this substressor; therefore, there would be no overlap between activities and shallow-water corals—including the proposed ESA-listed coral species. Given the low numbers used, most marine invertebrates would never be exposed to guidance wire. However, if the guidance wires drifted to near shore locations they could potentially entangle corals and cause abrasions, breakage, and potential mortality, though given the negatively buoyancy of these wires, this event is improbable.

The impact of guidance wires on marine invertebrates is not likely to cause injury or mortality to individuals, and impacts would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, (3) exposures would be localized, and (4) marine invertebrates are not particularly susceptible to entanglement stressors as most would avoid entanglement and simply be temporarily disturbed. Activities involving fiber optic cables and guidance wires are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during training activities as described under the No Action Alternative would have no effect on proposed ESA-listed coral species.

Testing Activities

Under the No Action Alternative, no events would occur that would expend fiber optic or guidance wires during testing events (Table 3.0-23 and Table 3.0-24).

3.8.3.4.1.2 Alternative 1

Training Activities

As indicated in Table 2.8-1, under Alternative 1, torpedoes expending guidance wire would occur throughout the Study Area during tracking exercises, all greater than 3 nm from the shore. Alternative 1 proposes a slight increase in the number of torpedoes used, 63, as compared to the 53 torpedoes and torpedo accessories that would be used under the No Action Alternative, though not all of these are heavyweight torpedoes which utilize guidance wires (40, Table 3.0-24). Alternative 1 would also introduce the usage of 16 fiber optic cables annually (Table 3.0-23). Due to the location of the activities, only pelagic and deep water benthic invertebrates could be exposed to this sub-stressor, and only slightly more than the exposure under the No Action Alternative; therefore, there would be no overlap between activities and shallow-water corals—including the proposed ESA-listed coral species. Given the low numbers used, most marine invertebrates would never be exposed to a cable or guidance wire. However, if the guidance wires drifted to near shore locations they could potentially entangle corals and cause abrasions, breakage, and potential mortality, though given the negatively buoyancy of these wires, this event is improbable.

The impact of fiber optic cables and guidance wires on marine invertebrates is not likely to cause injury or mortality to individuals, and impacts would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, (3) exposures would be localized, and (4) marine invertebrates are not particularly susceptible to entanglement stressors as most would avoid entanglement and simply be temporarily disturbed. Activities involving cables and guidance wires are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during training activities as described under Alternative 1 would have no effect on proposed ESA-listed coral species.

Testing Activities

Under Alternative 1, 60 torpedoes are utilized throughout the Study Area during torpedo testing (Table 3.0-24) though only 20 of those are heavyweight torpedoes that utilize guidance wires. Additionally, MCM Mission Package testing (Table 2.8-3) expends up to 48 fiber optic cables. All testing activities involving guidance wires would occur greater than 3 nm from the shore. Due to the location of the activities, only pelagic and deep water benthic invertebrates could be exposed to this stressor. There would be no overlap between activities and shallow-water corals—including the proposed ESA-listed coral species. Given the low numbers used, most marine invertebrates would never be exposed to a guidance wire from testing activities. However, if the guidance wires drifted to near shore locations they could potentially entangle corals and cause abrasions, breakage, and potential mortality, though given the negatively buoyancy of these wires, this event is improbable.

The impact of fiber optic cables and guidance wires on marine invertebrates is not likely to cause injury or mortality to individuals, and impacts would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, (3) exposures would be localized, and (4) marine invertebrates are not particularly susceptible to entanglement stressors as most would avoid entanglement and simply be temporarily disturbed. Activities involving cables and guidance wires are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during testing activities as described under Alternative 1 would have no effect on proposed ESA-listed coral species.

3.8.3.4.1.3 Alternative 2

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 for Alternative 1.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during training activities as described under Alternative 2 would have no effect on proposed ESA-listed coral species.

Testing Activities

Under Alternative 2, 70 torpedoes would be used throughout the Study Area though only 20 of those are heavyweight torpedoes that utilize guidance wires (Table 3.0-24). Additionally, MCM Mission Package testing (Table 2.8-3) expends up to 56 fiber optic cables. All testing activities involving guidance wires would occur greater than 3 nm from the shore. Due to the location of the activities, only pelagic and deep water benthic invertebrates could be exposed to this stressor. There would be no overlap between activities and shallow-water corals—including the proposed ESA-listed coral species. Given the low numbers used, most marine invertebrates would never be exposed to a cable or guidance wire from testing activities. However, if the guidance wires drifted to near shore locations they could potentially entangle corals and cause abrasions, breakage, and potential mortality, though given the negatively buoyancy of these wires, this event is improbable.

The impact of fiber optic cables and guidance wires on marine invertebrates is not likely to cause injury or mortality to individuals, and impacts would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, (3) exposures would be localized, and (4) marine invertebrates are not particularly susceptible to entanglement stressors as most would avoid entanglement and simply be temporarily disturbed. Activities involving cables and guidance wires are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels.

Pursuant to the ESA, the use of fiber optic cables and guidance wires expended during testing activities as described under Alternative 2 would have no effect on proposed ESA-listed coral species.

3.8.3.4.1.4 Substressor Impact on Sedentary Invertebrate Beds and Reefs as Essential Fish Habitat (Preferred Alternative)

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of fiber optic cables and guidance wires during training and testing activities could have an adverse effect on sedentary invertebrate beds or reefs that constitute

EFH or Habitat Areas of Particular Concern. The EFHA states that the impact to sedentary invertebrate beds (e.g., amphipod tubes, bryozoans) may be minimal and long-term.

3.8.3.4.2 Impacts from Decelerators/Parachutes

Decelerators/parachutes of varying sizes are used during training and testing activities. Sonobuoys, lightweight torpedoes, anti-submarine warfare training targets, and other devices deployed by aircraft use decelerators/parachutes that are made of cloth and nylon, and many have weights attached to the lines for rapid sinking. At water impact, the decelerator/parachute assembly is expended, and it sinks away from the unit. The decelerator/parachute assembly may remain at the surface for 5–15 seconds before the decelerator/parachute and its housing sink to the seafloor, where it becomes flattened (Section 3.0.5.3.4.2, Decelerators/Parachutes). Because they are in the air and water column for a time span of minutes, it is improbable that such a decelerator/parachute deployed in areas greater than 3 nm from shore (in water depths deeper than 183 m [600.4 ft.]) could travel far enough to affect shallow-water corals, including coral species proposed for ESA listing. Movement of the decelerator/parachute in the water may break more fragile invertebrates such as deep-water corals which would also reduce suitable hard substrate for encrusting organisms. Deep-water coral species potentially occur everywhere that decelerator/parachute use occurs. The proposed ESA-listed coral species are susceptible to entanglement in decelerators/ parachutes, but the principal mechanism of damage is abrasion or breakage; therefore, this potential stressor is addressed in Section 3.8.3.2.2 (Impacts from Military Expended Materials).

Decelerators/parachutes pose a potential, though unlikely, entanglement risk to susceptible marine invertebrates. The most likely method of entanglement would be a marine invertebrate crawling through the fabric or cord that then would tighten around it. A marine invertebrate that might become entangled could be temporarily confused and escape unharmed, held tightly enough that it could be injured during its struggle to escape, preyed upon while entangled, or starved while entangled. The likelihood of these outcomes cannot be predicted with any certainty because interactions between invertebrate species and entanglement hazards are not well known. The potential entanglement scenarios are based on observations of how marine invertebrates are entangled in marine debris (Environmental Sciences Group 2005; Ocean Conservancy 2010). Filter-feeding invertebrates such as deep water corals and sponges could be entangled in the fabric and suffocate or starve.

3.8.3.4.2.1 No Action Alternative

Training Activities

Under the No Action Alternative, 8,032 decelerators/parachutes would be expended during training activities (Table 3.0-25) and would be expended in locations greater than 3 nm from shore throughout the Study Area (in water typically deeper than 183 m [600.4 ft.]). Because they are in the air and water column for a time span of minutes, it is improbable that such a decelerator/parachute deployed greater than 3 nm from shore could travel far enough to affect shallow-water corals, including proposed ESA-listed coral species. Movement of the decelerator/parachute in the water may break more fragile invertebrates such as deep-water corals, which would also reduce suitable hard substrate for encrusting organisms. Filter-feeding invertebrates such as deep water corals and sponges could be entangled in the fabric and suffocate or starve.

Most marine invertebrates would never encounter a decelerator/parachute. The impact of decelerators/parachutes on marine invertebrates is not likely to cause injury or mortality to individuals, and impacts would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, (3) exposures would be localized, and (4) marine invertebrates are not particularly susceptible to entanglement stressors as most would avoid entanglement and simply be temporarily disturbed. Activities involving decelerators/parachutes are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels.

Pursuant to the ESA, the use of decelerators/parachutes expended during training activities as described under the No Action Alternative would have no effect on proposed ESA-listed coral species.

Testing Activities

Under the No Action Alternative, no testing activities that would create entanglement hazards from decelerators/parachutes are conducted in the Study Area.

3.8.3.4.2.2 Alternative 1

Training Activities

Under Alternative 1, 10,845 decelerators/parachutes would be expended (Table 3.0-25) during training activities. Decelerators/parachutes would be expended in areas greater than 3 nm from shore throughout the Study Area. Similar to the No Action Alternative, activities that expend sonobuoys and air-launched torpedo parachutes generally occur in water deeper than 183 m (600.4 ft.). Because they are in the air and water column for a time span of minutes, it is improbable that such a decelerator/parachute deployed over water deeper than 183 m (600.4 ft.) could travel far enough to affect shallow-water corals, including proposed ESA-listed coral species. Movement of the decelerator/parachute in deeper water may break more fragile invertebrates such as deep-water corals which would also reduce suitable hard substrate for encrusting organisms. Filter-feeding invertebrates such as deep water corals and sponges could be entangled in the fabric and suffocate or starve.

Most marine invertebrates would never encounter a decelerator/parachute. The impact of decelerators/parachutes on marine invertebrates is not likely to cause injury or mortality to individuals, and impacts would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, (3) exposures would be localized, and (4) marine invertebrates are not particularly susceptible to entanglement stressors as most would avoid entanglement and simply be temporarily disturbed. Activities involving decelerators/parachutes are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels.

Pursuant to the ESA, the use of decelerators/parachutes expended during training activities as described under Alternative 1 would have no effect on proposed ESA-listed coral species.

Testing Activities

Under Alternative 1, 1,727 decelerators/parachutes would be expended (Table 3.0-25) during testing activities. Decelerators/parachutes would be expended in areas greater than 3 nm from shore throughout the Study Area. Activities that expend sonobuoys and air-launched torpedo parachutes generally occur in water deeper than 183 m (600.4 ft.). Because they are in the air and water column for a time span of minutes, it is improbable that such a decelerator/parachute deployed over water deeper than 183 m (600.4 ft.) could travel far enough to affect shallow-water corals, including coral species currently proposed for ESA listing. Movement of the decelerator/parachute in the water may break more fragile invertebrates such as deep-water corals also reduce suitable hard substrate for encrusting organisms.

Most marine invertebrates would never encounter a decelerator/parachute from testing activities. The impact of decelerators/parachutes on marine invertebrates is not likely to cause injury or mortality to individuals, and impacts would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, (3) exposures would be localized, and (4) marine invertebrates are not particularly susceptible to entanglement stressors as most would avoid entanglement and simply be temporarily disturbed. Activities involving decelerators/parachutes are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels.

Pursuant to the ESA, the use of decelerators/parachutes expended during testing activities as described under Alternative 1 would have no effect on proposed ESA-listed coral species.

3.8.3.4.2.3 Alternative 2

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.

Pursuant to the ESA, the use of decelerators/parachutes expended during training activities as described under Alternative 2 would have no effect on proposed ESA-listed coral species.

Testing Activities

Under Alternative 2, 1,912 decelerators/parachutes would be expended (Table 3.0-25) during testing activities. Decelerators/parachutes would be expended in areas greater than 3 nm from shore throughout the Study Area. Activities that expend sonobuoys and air-launched torpedo parachutes generally occur in water deeper than 183 m (600.4 ft.). Because they are in the air and water column for a time span of minutes, it is improbable that such a decelerator/parachute deployed over water deeper than 183 m (600.4 ft.) could travel far enough to affect shallow-water corals, including coral species currently proposed for ESA-listing. Movement of the decelerator/parachute in the water may break more fragile invertebrates, such as deep-water corals, and also reduce suitable hard substrate for encrusting organisms.

Most marine invertebrates would never encounter a decelerator/parachute from testing activities. The impact of decelerators/parachutes on marine invertebrates is not likely to cause injury or mortality to individuals, and impacts would be inconsequential because: (1) the area exposed to the stressor is extremely small relative to most marine invertebrates' ranges, (2) the activities are dispersed such that few individuals could conceivably be exposed to more than one activity, (3) exposures would be localized, and (4) marine invertebrates are not particularly susceptible to entanglement stressors as most would avoid entanglement and simply be temporarily disturbed. Activities involving decelerators/parachutes are not expected to yield any behavioral changes or lasting impacts on the survival, growth, recruitment, or reproduction of invertebrate species at individual or population levels.

Pursuant to the ESA, the use of decelerators/parachutes expended during testing activities as described under Alternative 2 would have no effect on proposed ESA-listed coral species.

3.8.3.4.2.4 Substressor Impact on Sedentary Invertebrate Beds and Reefs as Essential Fish Habitat (Preferred Alternative)

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of decelerators/parachutes during training and testing activities could have an adverse effect on sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern. The EFHA states that the impact to sedentary invertebrate beds (e.g., amphipod tubes, bryozoans) may be minimal and long-term.

3.8.3.5 Ingestion Stressors

3.8.3.5.1 Impacts from Military Expended Materials

This section analyzes the potential ingestion impacts of the various types of military expended materials used by the Navy during training and testing activities within the Study Area. As presented in Section 3.0.3.5 (Ingestion Stressors), the Navy expends the following types of materials that could become ingestion stressors during training and testing in the Study Area: non-explosive practice munitions (small- and medium-caliber), fragments from explosives, fragments from targets, chaff, flare casings (including plastic end caps and pistons), and decelerators/parachutes. Other military expended materials such as targets, large-caliber projectiles, intact training and testing bombs, guidance wires, 55-gallon drums, sonobuoy tubes, and marine markers are too large for marine organisms to consume and are eliminated from further discussion. Expended materials could be ingested by marine invertebrates in all large marine ecosystems and open ocean areas. Ingestion could occur at the surface, in the water column, or on the seafloor, depending on the size and buoyancy of the expended object and the feeding behavior of the animal. Floating material is more likely to be eaten by animals that feed at or near the water surface, while materials that sink to the seafloor present a higher risk to both filter-feeding sessile and bottom-feeding animals. Marine invertebrates are universally present in the water and the seafloor, but the majority of individuals are smaller than a few millimeters (e.g., zooplankton, most roundworms, and most arthropods). Most military expended materials and fragments of military expended materials are too large to be ingested by marine invertebrates. The potential for marine invertebrates to encounter fragments of ingestible size increases as the military expended materials degrades into smaller fragments.

If expended material is ingested by marine invertebrates, the primary risk is from a blocked digestive tract. Most military expended materials are relatively inert in the marine environment, and are not likely to cause injury or mortality via chemical effects (see Section 3.8.3.6, Secondary Stressors, for more information on the chemical properties of these materials).

The most abundant military expended material of ingestible size is chaff. The materials in chaff are generally nontoxic in the marine environment except in quantities substantially larger than those any marine invertebrate could reasonably be exposed to from normal usage. Fibers are composed of an aluminum alloy coating on glass fibers of silicon dioxide. Chaff is similar in form to fine human hair, and somewhat analogous to the spicules of sponges or the siliceous cases of diatoms (Spargo 1999). Many invertebrates ingest sponges, including the spicules, without suffering harm (Spargo 1999). Marine invertebrates may occasionally encounter chaff fibers in the marine environment and may incidentally ingest chaff when they ingest prey or water. Literature reviews and controlled experiments suggest that chaff poses little environmental risk to marine organisms at concentrations that could reasonably occur from military training and testing (Arfsten et al. 2002; Spargo 1999). Studies were conducted to determine likely effects on marine invertebrates from ingesting chaff involving a laboratory investigation of crabs that were fed radiofrequency chaff. Blue crabs were force-fed a chaff-and-food mixture daily for a few weeks at concentrations 10 to 100 times predicted real-world exposure levels without a notable increase in mortality (Arfsten et al. 2002).

As described in Section 3.8.2 (Affected Environment), tens of thousands of marine invertebrate species inhabit the Study Area. There is little literature about the effects of debris ingestion on marine invertebrates; consequently, there is little basis for an evidence-based assessment of risks. It is not feasible to speculate on which invertebrates in which locations might ingest specific types of military expended materials. However, invertebrates that actively forage (e.g., worms, octopus, shrimp, and sea cucumbers) are at much greater risk of ingesting military expended materials than invertebrates that filter-feed (e.g., sponges, corals, oysters, and barnacles). Though ingestion is possible in some circumstances, based on the little scientific information available, it seems that negative impacts on individuals are unlikely and impacts on populations would be inconsequential and not detectable. Adverse consequences of marine invertebrates ingesting military expended materials are possible but not probable.

3.8.3.5.1.1 No Action Alternative

Training Activities

Under the No Action Alternative, a variety of potentially ingestible military expended materials (i.e., chaff) would be released to the marine environment by Navy training activities (Table 2.8-1). Ingestion is not likely in the majority of cases because most military expended materials are too large to be ingested by most marine invertebrates. Though ingestion is possible in some circumstances, based on the little scientific information available, it seems that negative impacts on individuals are unlikely and the potential for impacts on populations would be inconsequential and not detectable. Marine invertebrates may occasionally encounter chaff fibers in the marine environment and may incidentally ingest chaff when they ingest prey or water. Literature reviews and controlled experiments suggest that chaff poses little environmental risk to marine organisms at concentrations that could reasonably occur from military training and testing (Arfsten et al. 2002; Spargo 1999). Adverse consequences of marine invertebrates ingesting military expended materials are possible but not probable. The fraction of military expended materials of ingestible size, or that become ingestible after degradation, is unlikely to impact individuals.

Pursuant to the ESA, the use of military expended materials of ingestible size during training activities as described under the No Action Alternative would have no effect on proposed ESA-listed coral species.

Testing Activities

Under the No Action Alternative, no testing activities that would create ingestion stressors are conducted in the Study Area.

3.8.3.5.1.2 Alternative 1

Training Activities

Under Alternative 1, a variety of potentially ingestible military expended materials would be released to the marine environment by Navy training activities. As with the No Action Alternative, ingestion is not likely because most military expended materials are too large to be ingested by most marine invertebrates. The fraction of military expended materials that are of ingestible size, or that become ingestible after degradation, may impact individual marine invertebrates, but are unlikely to have impacts on populations or sub-populations.

Under Alternative 1, the expended chaff would increase to 25,840 canisters per year in areas greater than 12 nm from shore within the Study Area compared with the No Action Alternative of 5,830 (Table 3.0-26). Marine invertebrates may occasionally encounter chaff fibers in the marine environment and may incidentally ingest chaff when they ingest prey or water. Literature reviews and controlled experiments suggest that chaff poses little environmental risk to marine organisms at concentrations that could reasonably occur from military training and testing (Arfsten et al. 2002, Spargo 1999). Adverse consequences of marine invertebrates ingesting military expended materials are possible but not probable.

Pursuant to the ESA, the use of military expended materials of ingestible size during training activities as described under Alternative 1 would have no effect on proposed ESA-listed coral species.

Testing Activities

Under Alternative 1, a variety of potentially ingestible military expended materials would be released to the marine environment by Navy testing activities. Six hundred chaff canisters and 300 flares would be released during testing activities under Alternative 1. Ingestion is not likely in the majority of cases because most military expended materials are too large to be ingested by most marine invertebrates. The fractions of military expended materials that are of ingestible size, or become ingestible after degradation, are unlikely to impact individuals. Marine invertebrates may occasionally encounter chaff fibers in the marine environment and may incidentally ingest chaff when they ingest prey or water. Literature reviews and controlled experiments suggest that chaff poses little environmental risk to marine organisms at concentrations that could reasonably occur from military training and testing (Arfsten et al. 2002, Spargo 1999). Adverse consequences of marine invertebrates ingesting military expended materials are possible but not probable.

Pursuant to the ESA, the use of military expended materials of ingestible size during testing activities as described under Alternative 1 would have no effect on proposed ESA-listed coral species.

3.8.3.5.1.3 Alternative 2

Training Activities

Under Alternative 2, the expended chaff would increase to 28,512 canisters per year in areas greater than 12 nm from shore within the Study Area compared with the No Action Alternative of 5,836 (Table 3.0-26). Though the number of canisters increases, it remains that chaff poses little environmental risk to marine organisms at concentrations that could reasonably occur from military training and testing (Arfsten et al. 2002, Spargo 1999). Adverse consequences of marine invertebrates ingesting military expended materials are possible but not probable.

Pursuant to the ESA, the use of military expended materials of ingestible size during training activities as described under Alternative 2 would have no effect on proposed ESA-listed coral species.

Testing Activities

Under Alternative 2, a variety of potentially ingestible military expended materials would be released to the marine environment by Navy testing activities. Six hundred sixty chaff canisters and 330 flares would be released during testing activities under Alternative 2. Ingestion is not likely in the majority of cases because most military expended materials are too large to be ingested by most marine invertebrates. The fractions of military expended materials that are of ingestible size, or become ingestible after degradation, are unlikely to impact individuals. Marine invertebrates may occasionally encounter chaff fibers in the marine environment and may incidentally ingest chaff when they ingest prey or water.

Literature reviews and controlled experiments suggest that chaff poses little environmental risk to marine organisms at concentrations that could reasonably occur from military training and testing (Arfsten et al. 2002, Spargo 1999). Adverse consequences of marine invertebrates ingesting military expended materials are possible but not probable.

Pursuant to the ESA, the use of military expended materials of ingestible size during testing activities as described under Alternative 2 would have no effect on proposed ESA-listed coral species.

3.8.3.5.1.4 Substressor Impact on Sedentary Invertebrate Beds and Reefs as Essential Fish Habitat (Preferred Alternative)

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of potentially ingestible military expended materials during training and testing activities could have an adverse effect on sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern. The EFHA states that the impact to sedentary invertebrate beds (e.g., amphipod tubes, bryozoans) may be minimal and long term.

3.8.3.5.2 Summary of Ingestion Impacts

Most military expended materials and fragments of military expended materials are too large to be ingested by marine invertebrates. The potential for marine invertebrates to encounter fragments of ingestible size increases as the military expended materials degrade into smaller fragments. The fractions of military expended materials of ingestible size, or that become ingestible after degradation, may impact individual marine invertebrates, but are unlikely to impact populations.

3.8.3.6 Secondary Stressors

This section analyzes potential impacts on marine invertebrates exposed to stressors indirectly through sediment and water. These two ecosystem constituents, sediment and water, are also primary constituents of marine invertebrate habitat and clear distinctions between indirect impacts and habitat impacts are difficult to maintain. For this analysis, indirect impacts on marine invertebrates via sediment or water that do not require trophic transfers (e.g., bioaccumulation) to be observed are considered here. The terms "indirect" and "secondary" do not imply reduced severity of environmental consequences, but instead describe *how* the impact may occur in an organism or its ecosystem.

Stressors from Navy training and testing activities could pose secondary or indirect impacts on marine invertebrates via habitat, sediment, or water quality. These include (1) explosives and byproducts; (2) metals; (3) chemicals; and (4) other materials such as targets, chaff, and plastics.

3.8.3.6.1 Explosives and Explosive Byproducts

High-order explosives consume most of the explosive material, creating typical combustion products. In the case of Royal Demolition Explosive, 98 percent of the combustion products are common seawater constituents and the remainder is rapidly diluted. Explosive byproducts from high order detonations present no indirect impacts to marine invertebrates through sediment or water. Low-order detonations and unexploded ordnance present an elevated likelihood of effects on marine invertebrates, and the potential impacts of these on marine invertebrates will be analyzed. Explosive material not completely consumed during a detonation from ordnance disposal and mine clearance training are collected after training is complete; therefore, potential impacts are assumed to be inconsequential and not detectable for these training and testing activities. Marine invertebrates may be exposed by contact with the explosive, contact with contaminants in the sediment or water, and ingestion of contaminated sediments. Most marine invertebrates are very small relative to ordnance or fragments, and direct ingestion of unexploded ordnance is unlikely.

Indirect impacts of explosives and unexploded ordnance on marine invertebrates via sediment are possible near the ordnance. Degradation of explosives proceeds via several pathways as discussed in Section 3.1 (Sediments and Water Quality). Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen and Lotufo 2010). Trinitrotoluene and its degradation products impact developmental processes in marine invertebrates and are acutely toxic to adults at concentrations similar to real-world exposures (Rosen and Lotufo 2007b, 2010). The relatively low solubility of most explosives and their degradation products indicate 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 inches (15 to 30 centimeters) away from degrading ordnance, the concentrations of these compounds were not statistically distinguishable from background beyond 3 and 6 ft. (1 and 1.8 m) from the degrading ordnance (Section 3.1.3.1, Explosives and Explosive Byproducts). Taken together, marine invertebrates, eggs, and larvae probably would be adversely impacted by the indirect effects of degrading explosives within a very small radius of the explosive (1 to 6 ft. [0.3 to 1.8 m]).

Indirect impacts of explosives and unexploded ordnance on marine invertebrates via water are likely to be inconsequential and not detectable for two reasons. First, most explosives and explosive degradation products have very low solubility in sea water (Section 3.1, Sediments and Water Quality). This means that dissolution occurs extremely slowly, and harmful concentrations of explosives and degradation are not likely to accumulate except within confined spaces. Second, a low concentration of contaminants, slowly delivered into the water column, is readily diluted to non-harmful concentrations. Filter feeders in the immediate vicinity of degrading explosives may be more susceptible to bioaccumulation of contaminants. While marine invertebrates may be adversely impacted by the indirect effects of degrading explosives via water (Rosen and Lotufo 2007a, 2010), this is extremely unlikely in realistic scenarios.

Impacts on marine invertebrates, including zooplankton, eggs, and larvae, are likely within a very small radius of the ordnance (1 to 6 ft. [0.3 to 1.8 m]). These impacts may continue as the ordnance degrades over months to decades. Because most ordnance is deployed as projectiles, multiple unexploded or low-order detonations would accumulate on spatial scales of 1 to 6 ft. (0.3 to 1.8 m); therefore, potential impacts are likely to remain local and widely separated. Given these conditions, the possibility of population-level impacts on marine invertebrates is inconsequential. However, if the sites of the depositions are the same over time, this could alter the benthic composition, affect bioaccumulation, and impact local invertebrate communities.

3.8.3.6.2 Metals

Certain metals and metal-containing compounds are harmful to marine invertebrates at concentrations above background levels (e.g., cadmium, chromium, lead, mercury, zinc, copper, manganese, and many others) (Negri et al. 2002; Wang and Rainbow 2008). 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). Many metals bioaccumulate and some physiological impacts begin to occur only after several trophic transfers concentrate the toxic metals. Indirect impacts of metals on marine invertebrates via sediment and water involve concentrations several orders of magnitude lower than concentrations achieved via bioaccumulation. Marine invertebrates may be exposed by contact with the metal, contact with contaminants in the sediment or water, and ingestion of contaminated sediments. Ingested metal contaminants are toxic at substantially lower effective concentrations than contaminants dissolved or suspended in the water. Most marine invertebrates are very small relative to Navy military expended materials, and direct ingestion of metals is unlikely.

Because metals often concentrate in sediments, potential adverse indirect impacts are much more likely via sediment than via water. Despite the acute toxicity of some metals (e.g., hexavalent chromium or tributyltin) (Negri et al. 2002) concentrations above safe limits are rarely encountered even in live-fire areas such as Vieques (which is not in the MITT Study Area) where deposition of metals from Navy activities is very high. Pait (2010) and others sampled in areas in which live ammunition and weapons were used. Other studies described in Section 3.1.3.2 (Metals) find no harmful concentrations of metals from deposition of military metals into the marine environment. Marine invertebrates, eggs, or larvae could be indirectly impacted by metals via sediment within a few inches of the object.

Concentrations of metals in sea water are orders of magnitude lower than concentrations in marine sediments. Marine invertebrates probably would not be indirectly impacted by Navy-derived toxic metals via the water, in the absence of bioaccumulation. It is conceivable, though extremely unlikely, that marine invertebrates, eggs, or larvae could be indirectly impacted by metals via sediment within a few inches of the object, but these potential impacts would be localized and widely separated. Concentrations of metals in water are extremely unlikely to be high enough to cause injury or mortality to marine invertebrates; therefore, indirect impacts of metals via water are likely to be inconsequential and not detectable. Given these conditions, the possibility of population-level impacts on marine invertebrates is likely to be inconsequential and not detectable.

3.8.3.6.3 Chemicals

Several Navy training and testing activities introduce potentially harmful chemicals into the marine environment; principally, flares and propellants from 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 invertebrates from flares, missiles, and rocket propellants is perchlorate, which is highly soluble in water, persistent, and impacts metabolic processes in many plants and animals. Torpedo propellant poses little risk to marine invertebrates because the chemicals have relatively low toxicity (Section 3.1.3.3, Chemicals Other Than Explosives). Marine invertebrates may be exposed by contact with the chemical, contact with chemical contaminants in the sediment or water, and ingestion of contaminated sediments. These situations typically include rapid dilution and doses large enough to have detectable impacts are uncommon in most circumstances.

The principal toxic component of missiles and rockets is perchlorate, which is highly soluble and does not readily adsorb to sediments. Therefore, missile and rocket fuel poses inconsequential risks of indirect impacts on marine invertebrates 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). Marine invertebrates, eggs, or larvae could be indirectly impacted by propellants via sediment near the object (e.g., within a few inches), but these potential impacts would diminish rapidly as the propellant degrades.

In seawater, however, perchlorate, the principal ingredient of solid missile and rocket propellant, is highly soluble, persistent, and impacts metabolic processes in many plants and animals. Perchlorate contamination rapidly disperses throughout the water column and water within sediments. While it impacts terrestrial biological processes at low concentrations (e.g., less than 10 parts per billion), toxic concentrations are unlikely to be encountered in seawater due to its rapid dispersement throughout the water column. The principal mode of perchlorate toxicity in the environment is bioaccumulation, which is discussed separately (Section 2.4.1.1 [Bioaccumulation]; Department of the Navy 2012).

Torpedo propellants have relatively low toxicity and pose an inconsequential risk to marine invertebrates. It is conceivable that marine invertebrates, zooplankton, eggs, or larvae could be indirectly impacted by hydrogen cyanide produced by torpedo fuel combustion, but these impacts would diminish rapidly as the chemical becomes diluted below toxic levels. Chemicals are rapidly diluted, readily biodegraded, or both, and concentrations high enough to be acutely toxic are unlikely in the marine environment (see Section 3.1.3.3, Chemicals Other than Explosives, for a discussion of these mechanisms). Concentrations of chemicals in sediment and water are not likely to cause injury or mortality to marine invertebrates; therefore, indirect impacts of chemicals via sediment and water are likely to be inconsequential and not detectable. Potential impacts of chemicals after bioaccumulation are discussed separately. Because of these conditions, population-level impacts on marine invertebrates are likely to be inconsequential and not detectable.

3.8.3.6.4 Other Materials

Military expended materials that are re-mobilized after their initial contact with the seafloor (e.g., by waves or currents) may continue to strike or abrade marine invertebrates. Secondary physical strike and disturbances are relatively unlikely because most expended materials are more dense than the surrounding sediments (i.e., metal), and are likely to remain in place as the surrounding sediment moves. The principal exception is likely to be decelerators/parachutes, which are moved easily relative to projectiles and fragments. Potential secondary physical strike and disturbance impacts may cease only: (1) when the military expended materials is too massive to be mobilized by typical oceanographic processes, (2) when the military expended material becomes encrusted by natural processes and incorporated into the seafloor, or (3) when the military expended materials becomes permanently buried. The fitness of individual organisms would be impacted directly or indirectly, but not to the extent that the viability of populations or species would be impacted.

All military expended material, including targets and vessel hulks used for Sinking Exercises that contain materials other than metals, explosives, or chemicals, is evaluated for potential indirect impacts on marine invertebrates via sediment and water. Principal components of these military expended materials include aluminized fiberglass (chaff); carbon or Kevlar fiber (missiles); and plastics (canisters, targets, sonobuoy components, decelerators/parachutes, etc.). Potential effects of these materials are discussed in Section 3.1.3.4 (Other Materials). Chaff has been extensively studied, and no indirect toxic effects are known to occur at realistic concentrations in the marine environment (Arfsten et al. 2002). Glass, carbon, and Kevlar fibers have no known potential toxic effects on marine invertebrates. Plastics contain chemicals which could indirectly affect marine invertebrates (Derraik 2002; Mato et al. 2001; Teuten et al. 2007). Marine invertebrates may be exposed by contact with the plastic, contact with associated plastic chemical contaminants in the sediment or water, or ingestion of contaminated sediments. Most marine invertebrates are very small relative to Navy military expended materials or fragments of military expended materials, and direct ingestion of plastics is unlikely.

The only material that could impact marine invertebrates via sediment is plastics. Harmful chemicals in plastics interfere with metabolic and endocrine processes in many plants and animals (Derraik 2002). Potentially harmful chemicals in plastics are not readily adsorbed to marine sediments; instead, marine invertebrates are most at risk via ingestion or bioaccumulation (Section 3.8.3.5, Ingestion Stressors; this section; and Section 3.3, Marine Habitats). Because plastics retain many of their chemical properties as they are physically degraded into microplastic particles (Singh and Sharma 2008), the exposure risks to marine invertebrates are dispersed over time. Marine invertebrates could be indirectly impacted by chemicals from plastics but, absent bioaccumulation, these impacts would be limited to direct contact with the material. Because of these conditions, population-level impacts on marine invertebrates attributable to Navy expended materials are likely to be inconsequential and not detectable.

Pursuant to the ESA, secondary stressors from training and testing activities under the No Action Alternative, Alternative 1, and Alternative 2 would have no effect on proposed ESA-listed coral species.

3.8.3.6.5 Substressor Impact on Sedentary Invertebrate Beds and Reefs as Essential Fish Habitat (Preferred Alternative)

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of metal, chemical, and other material contaminants, and secondary physical disturbances during training and testing activities, will have no adverse effect on sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern. The use of explosives, explosive byproducts, and unexploded ordnance during training and testing activities may have an adverse effect on sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern. The EFHA states that substressor impacts on invertebrate beds or reefs would be minimal and short-term within the Study Area.

3.8.4 SUMMARY OF POTENTIAL IMPACTS ON MARINE INVERTEBRATES

3.8.4.1 Combined Impacts of All 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 sections above. Stressors associated with Navy training and testing activities do not typically occur in isolation but rather occur in some combination. For example, mine neutralization activities include elements of acoustic, physical disturbance and strike, entanglement, ingestion, and secondary stressors that are all coincident in space and time. An analysis of the combined impacts of all stressors considers the potential consequences of aggregate exposure to all stressors and the repetitive or additive consequences of exposure over multiple years. This analysis makes the reasonable assumption that the majority of exposures to stressors are non-lethal, and instead focuses on consequences potentially impacting the organism's fitness (e.g., physiology, behavior, reproductive potential).

It is unlikely that mobile or migratory marine invertebrates that occur within the water column would be exposed to multiple activities during their lifespan because they are relatively short-lived, and most Navy training and testing activities impact small widely-dispersed areas. It is much more likely that stationary organisms or those that only move over a small range (e.g., corals, worms, and sea urchins) would be exposed to multiple activities because many Navy activities recur in the same location (e.g., gunnery and mine warfare).

Multiple stressors can co-occur with marine invertebrates in two general ways. The first would be if a marine invertebrate were exposed to multiple sources of stress from a single activity. The second is exposure to a combination of stressors over the course of the organism's life. Both general scenarios are more likely to occur where training and testing activities are concentrated. The key difference between the two scenarios is the amount of time between exposures to stressors. Time is an important factor because some stressors develop over a long period while others occur and pass quickly (e.g., dissolution of secondary stressors into the sediment versus physical disturbance). Similarly, time is an important factor for the organism because subsequent disturbances or injuries often increase the time needed for the organism to recover to baseline behavior/physiology, extending the time that the organism's fitness is impacted.

Marine invertebrates are susceptible to multiple stressors, and susceptibilities of many species are enhanced by additive or synergistic effects of multiple stressors. The global decline of corals, for example, is driven primarily by synergistic impacts of pollution, ecological consequences of overfishing, and climate change. As discussed in the analyses above, marine invertebrates are not particularly susceptible to energy, entanglement, or ingestion stressors resulting from Navy activities; therefore, the opportunity for Navy stressors to result in additive or synergistic consequences is most likely limited to acoustic, physical strike and disturbance, and secondary stressors.

Despite uncertainty in the nature of consequences resulting from combined impacts, the location of potential combined impacts can be predicted with more certainty because combinations are much more likely in locations that training and testing activities are concentrated. However, analyses of the nature of potential consequences of combined impacts of all stressors on marine invertebrates remain largely qualitative and speculative. Where multiple stressors coincide with marine invertebrates, the likelihood of a negative consequence is elevated but it is not feasible to predict the nature of the consequence or its likelihood because not enough is known about potential additive or synergistic interactions. Even for shallow-water coral reefs, an exceptionally well-studied resource, predictions of the consequences of multiple stressors are semi-quantitative and generalized predictions remain qualitative (Hughes and Connell 1999; Jackson 2008; Norström et al. 2009). It is also possible that Navy stressors will combine with non-Navy stressors, and this is qualitatively discussed in Chapter 4 (Cumulative Impacts).

3.8.4.2 Endangered Species Act Determinations

Table 3.8-4 summarizes the Navy’s determination of effect on proposed ESA-listed marine invertebrates for each stressor based on the previous analysis sections. Accordingly, the Navy is including the 40 species of corals currently proposed for ESA listing the Section 7 ESA consultation with NMFS. No other proposed ESA-listed invertebrate species or species in currently proposed for ESA listing occur within the Study Area.

3.8.4.3 Essential Fish Habitat Determinations

Pursuant to the EFH requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of sonar and other acoustic sources; vessel noise; swimmer defense airguns; weapons firing noise; vessel movement; in-water devices; and metal, chemical, or other material contaminants will have no adverse effect on sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern. The use of explosives, electromagnetic sources, military expended materials, seafloor devices, and explosives and explosive byproduct contaminants may have an adverse effect on EFH by reducing the quality and quantity of sedentary invertebrate beds or reefs that constitute EFH or Habitat Areas of Particular Concern. The EFHA states that individual stressor impacts were all either no effect, or minimal and ranged in duration from temporary to permanent, depending on the stressor.

Table 3.8-4: Summary of Endangered Species Act Determinations for Marine Invertebrates for the Preferred Alternative (Alternative 1)

Stressor		Proposed ESA-listed Corals
Acoustic Stressors		
Sonar and Other Active Acoustic Sources	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Explosives and Other Impulsive Acoustic Sources	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Energy Stressors		
Electromagnetic Devices	Training Activities	No Effect
	Testing Activities	No Effect
Physical Disturbance and Strike Stressors		
Vessels and In-water Devices	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Military Expended Materials	Training Activities	May affect, not likely to adversely affect
	Testing Activities	May affect, not likely to adversely affect
Seafloor devices	Training Activities	No Effect
	Testing Activities	No Effect
Entanglement Stressors		
Fiber Optic Cables and Guidance Wires	Training Activities	No Effect
	Testing Activities	No Effect
Decelerators/parachutes	Training Activities	No Effect
	Testing Activities	No Effect
Ingestion Stressors		
Military Expended Materials	Training Activities	No Effect
	Testing Activities	No Effect
Secondary Stressors		
Explosives, Explosive Byproducts, Unexploded Ordnance, Metals, Chemicals, and Other Materials	Training Activities	No Effect
	Testing Activities	No Effect

REFERENCES

Abraham T., Beger M., Burdick D., Cochrane E., Craig, P., Didonato G., Fenner D., Green S., Golbuu Y., Gutierrez J., Hasurmai M., Hawkins C., Houk P., Idip D., Jacobson D., Joseph E., Keju T., Kuartei J., Palik S., Penland L., Pinca S., Rikim K., Starmer J., Trianni M., Victor S. Whaylen, L. (2004). Status Of The Coral Reefs In Micronesia And American Samoa. In: *Status of Coral Reefs of the World*: 2004. Ruth Kelty And Jason Kuartei (Eds.). Global Coral Ref Monitoring Network.

Aeby, G., Lovell, E., Richards, Z., Delbeek, J.C., Reboton, C. & Bass, D. (2008). *Acropora tenella*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Andre, M., Solé M., Lenoir M., Durfort M., Quero C., Mas A., Lombarte A., van der Schaar M., López-Bejar M., Morell M., Zaugg S., and Houégnigan L. (2011). Low-frequency sounds induce acoustic trauma in cephalopods. *Frontiers in Ecology and the Environment*, 9(9).

Appeltans, W., Bouchet, P., Boxshall, G. A., Fauchald, K., Gordon, D. P., Hoeksema, B. W., Costello, M. J. (2010). *World Register of Marine Species*. [Web page]. Retrieved from http://www.marinespecies.org/index.php, 01 November 2011.

Arfsten, D. P., Wilson, C. L. & Spargo, B. J. (2002). Radio Frequency Chaff: The Effects of Its Use in Training on the Environment. *Ecotoxicology and Environmental Safety, 53*(1), 1–11. DOI: 10.1006/eesa.2002.2197.

Bickel, S. L., Malloy Hammond, J. D. & Tang, K. W. (2011). Boat-generated turbulence as a potential source of mortality among copepods. *Journal of Experimental Marine Biology and Ecology, 401*(1–2), 105–109. DOI: 10.1016/j.jembe.2011.02.038

Bisby, F. A., Roskov, Y. R., Orrell, T. M., Nicolson, D., Paglinawan, L. E., Bailly, N., Baillargeon, G. (2010). *Species 2000 & ITIS Catalogue of Life: 2010 Annual Checklist*. [Online database] Species 2000. Retrieved from http://www.catalogueoflife.org/annual-checklist/2010/browse/tree, 05 September 2010.

Bishop, M. J. (2008, January). Displacement of epifauna from seagrass blades by boat wake. [Article]. *Journal of Experimental Marine Biology and Ecology, 354*(1), 111-118. 10.1016/j.jembe.2007.10.013 Retrieved from <Go to ISI>://000252599600011.

Boulon, R., Chiappone, M., Halley, R., Jaap, W., Keller, B., Kruczynski, B., Rogers, C. (2005). *Atlantic Acropora status review document report to National Marine Fisheries Service, Southeast Regional Office*. Available from *http://sero.nmfs.noaa.gov/pr/pdf/050303%20status%20review.pdf.*

Brainard, R.E., C. Birkeland, C.M. Eakin, P. McElhany, M.W. Miller, M. Patterson, and G.A. Piniak. (2011). Status review report of 82 candidate coral species petitioned under the U.S. Endangered Species Act. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-27, 530 p. + 1 Appendix.

Brierley, A. S., Fernandes, P. G., Brandon, M. A., Armstrong, F., Millard, N. W., McPhail, S. D., Griffiths, G. (2003). An investigation of avoidance by Antarctic krill of RRS *James Clark Ross* using the *Autosub*-2 autonomous underwater vehicle. *Fisheries Research, 60*, 569-576.

Brown, B. E. (1997). Coral bleaching: causes and consequences. *Coral Reefs, 16*(5), S129–S138. 10.1007/s003380050249.

Brusca, R. C. & Brusca, G. J. (2003). Phylum Cnidaria. In *Invertebrates* (pp. 219–283). Sunderland: Sinauer Associates, Inc.

Bryant, D., Burke, L., McManus, J. & Spalding, M. D. (1998). *Reefs at Risk: A Map Based Indicator of Threats to the Word's Coral Reefs.* (pp. 56). Washington, D.C: World Resources Institute.

Budelmann, B. U. (2010). Cephalopoda, in *The UFAW Handbook on the Care and Management of Laboratory and Other Research Animals, Eighth Edition* (eds R. Hubrecht and J. Kirkwood), Wiley-Blackwell, Oxford, UK.

Burdick, D., V. Brown, J. Asher, M. Gawel, L. Goldman, A. Hall, J. Kenyon, T. Leberer, E. Lundblad, J. Mcllwain, J. Miller, D. Minton, M. Nadon, N. Pioppi, L. Raymundo, B. Richards, R. Schroeder, P. Schupp, E. Smith and B. Zgliczynski. (2008). The State of Coral Reef Ecosystems of Guam. pp. 465-510. *In*: J.E. Waddell and A.M. Clarke (eds.), The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2008. NOAA Technical Memorandum NOS NCCOS 73. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team. Silver Spring, MD. 569 pp.

Burke, L. & Maidens, J. (2004). *Reefs at Risk in the Caribbean* (pp. 80). Washington, D.C.: World Resources Institute.

Caribbean Fishery Management Council. (1994). *Fishery Management Plan, Regulatory Impact Review and Final Environmental Impact Statement for Corals and Reef Associated Plants and Invertebrates of Puerto Rico and the U. S. Virgin Islands* (p. 85). San Juan, Puerto Rico: Caribbean Fishery Management Council. Available from http://www.caribbeanfmc.com/SCANNED%20FMPS/coral%20fmp/coralFMP.htm

Carilli, J. E., Norris, R. D., Black, B., Walsh, S. M. & McField, M. (2010). Century-scale records of coral growth rates indicate that local stressors reduce coral thermal tolerance threshold. *Global Change Biology, 16*(4), 1247-1257. doi: 10.1111/j.1365-2486.2009.02043.x

Castro, P. & Huber, M. E. (2000). Marine animals without a backbone. In *Marine Biology* (3rd ed., pp. 104–138). McGraw-Hill.

Cato, D. H. & Bell, M. J. (1992). Ultrasonic ambient noise in Australian shallow waters at frequencies up to 200 kHz. (MRL-TR-01-23).

Center for Biological Diversity. (2009). Petition to List 83 Coral Species under the Endangered Species Act.

Chan, A. A. Y. H., Stahlman, W. D., Garlick, D., Fast, C. D., Blumstein, D. T. & Blaisdell, A. P. (2010). Increased amplitude and duration of acoustic stimuli enhance distraction. *Animal Behaviour, 80*, 1075–1079.

Chesapeake Biological Laboratory. (1948). Effects of Underwater Explosions on Oysters, Crabs and Fish S. o. M. B. o. N. Resources (Ed.), [Preliminary Report]. Solomons Island, Maryland.

Christian, J. R., Mathieu, A., Thomson, D. H., White, D. & Bauchanan, R. A. (2003). Effect of Seismic Energy on Snow Crab (*Chionoecetes opilio*) e. r. a. LGL Ltd. (Ed.).

Chuenpagdee, R., Morgan, L. E., Maxwell, S. M., Norse, E. A. & Pauly, D. (2003, December). Shifting gears: assessing collateral impacts of fishing methods in US waters. [Review]. *Frontiers in Ecology and the Environment, 1*(10), 517–524.

Cohen, A. L., McCorkle, D. C., de Putron, S., Gaetani, G. A. & Rose, K. A. (2009). Morphological and compositional changes in the skeletons of new coral recruits reared in acidified seawater: Insights into the biomineralization response to ocean acidification. *Geochemistry Geophysics Geosystems, 10*(7), Q07005. doi:10.1029/2009gc002411

Colgan, M.W. (1987). Coral Reef Recovery on Guam (Micronesia) After Catastrophic Predation by *Acanthaster planci*. Ecology 68(6): 1592–1605.

Colin, P. L. & Arneson, A. C. (1995a). Cnidarians: Phylum *Cnidaria*. In *Tropical Pacific Invertebrates: A Field Guide to the Marine Invertebrates Occurring on Tropical Pacific Coral Reefs, Seagrass Beds and Mangroves* (pp. 63–139). Beverly Hills, CA: Coral Reef Press.

Colin, P. L. & Arneson, A. C. (1995b). Echinoderms: Phylum *Echinodermata*. In *Tropical Pacific Invertebrates: A Field Guide to the Marine Invertebrates Occurring on Tropical Pacific Coral Reefs, Seagrass Beds and Mangroves* (pp. 235–266). Beverly Hills, CA: Coral Reef Press.

Colin, P. L. & Arneson, A. C. (1995c). Molluscs: Phylum *Mollusca*. In *Tropical Pacific Invertebrates: A Field Guide to the Marine Invertebrates Occurring on Tropical Pacific Coral Reefs, Seagrass Beds and Mangroves* (pp. 157–200). Beverly Hills, CA: Coral Reef Press.

Colin, P. L. & Arneson, A. C. (1995d). Sponges: Phylum *Porifera*. In *Tropical Pacific Invertebrates: A Field Guide to the Marine Invertebrates Occurring on Tropical Pacific Coral Reefs, Seagrass Beds and Mangroves* (pp. 17–62). Beverly Hills, CA: Coral Reef Press.

Collins, A. G. & Waggoner, B. (2006, Last updated 28 January 2000). *Introduction to the Porifera*. [Web page] University of California Museum of Paleontology. Retrieved from http://www.ucmp.berkeley.edu/porifera/porifera.html, 13 September 2010.

Cortes N, J. & Risk, M. J. (1985). A reef under siltation stress: Cahuita, Costa Rica. *Bulletin of Marine Science, 36*(2), 339-356. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-0022177985&partnerID=40&md5=7b3adeceda67f8cafab3bf19af287bae

Cortés, J., Edgar, G., Chiriboga, A., Sheppard, C., Turak, E. & E. Wood. (2008). *Psammocora stellata*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>. 17 November 2011.

Cox, E. F. (1986). The effects of a selective corallivore on growth rates and competition for space between two species of Hawaiian corals. Journal of Experimental Marine Biology Ecology, 101:161–174.

Department of Defense. (2000). *Coral Reef Protection Implementation Plan*. (pp. 86). Prepared for U.S. Coral Reef Task Force. Available from http://secnavportal.donhq.navy.mil/portal/server.pt/gateway/PTARGS_0_0_2406_302_37445_43/http%3B/portalcontent.donhq.navy.mil%3B7087/publishedcontent/publish/secnav_portal/dasn_e_/natural_and_cultural_resources_conservation/natural_and_cultural_resources_highlights/dod_coral_reef_implem_plan.pdf

Department of the Navy, Naval Facilities Engineering Command & Atlantic Division. (2012). Ecosystem Technical Report version 3 for the Atlantic Fleet Training and Testing (AFTT) Draft Environmental Impact Statement. (pp. 69). Prepared by Tetra Tech Inc. Available from http://www.ttcollab.com/teammarine/Task%20Orders/Forms/AllItems.aspx?RootFolder=%2fteammarine%2fTask%20Orders%2fTO46%20Atlantic%20EIS%2fDeliverables%2fTask_7%2fDEIS%20v%2e3&FolderCTID=&View=%7b8D69BFE4-ED90-4BA7-BE65-F742CA308804%7d

Derraik, J. G. B. (2002). The pollution of the marine environment by plastic debris: A review. *Marine Pollution Bulletin, 44*(9), 842-852. doi: 10.1016/S0025-326X(02)00220-5

DeVantier, L., Hodgson, G., Huang, D., Johan, O., Licuanan, A., Obura, D., Sheppard, C., Syahrir, M. & Turak, E. (2008a). Montipora caliculata. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

DeVantier, L., Hodgson, G., Huang, D., Johan, O., Licuanan, A., Obura, D., Sheppard, C., Syahrir, M. & Turak, E. (2008b). Montipora lobulata. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

DeVantier, L., Hodgson, G., Huang, D., Johan, O., Licuanan, A., Obura, D., Sheppard, C., Syahrir, M. & Turak, E. (2008c). *Montipora patula*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

DeVantier, L., Hodgson, G., Huang, D., Johan, O., Licuanan, A., Obura, D., Sheppard, C., Syahrir, M. & Turak, E. (2008d). *Barabattoia laddi*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Downs, C. A., Kramarsky-Winter, E., Woodley, C. M., Downs, A., Winters, G., Loya, Y. & Ostrander, G. K. (2009). Cellular pathology and histopathology of hypo-salinity exposure on the coral *Stylophora pistillata*. *Science of the Total Environment, 407*(17), 4838–4851. doi: 10.1016/j.scitotenv.2009.05.015

Dubinsky, Z. & Berman-Frank, I. (2001). Uncoupling primary production from population growth in photosynthesizing organisms in aquatic ecosystems. *Aquatic Sciences, 63*(1), 4-17. Retrieved from http://www.scopus.com/scopus/inward/record.url?eid=2-s2.0-0035089069&partnerID=40

Eldredge, L. G. (2003). A retrospective look at Guam's marine biodiversity. *Micronesica* 35-36: 26-37.

Environmental Sciences Group. (2005). *CFMETR Environmental Assessment Update 2005*. (RMC-CCE-ES-05-21, pp. 652). Kingston, Ontario: Environmental Sciences Group, Royal Military College.

Fox, H. E. & Caldwell, R. L. (2006). Recovery from blast fishing on coral reefs: a tale of two scales. *Ecological Applications, 16*(5), 1631-1635.

Freiwald, A., Fosså, J. H., Grehan, A., Koslow, T. & Roberts, J. M. (2004). *Cold-water coral reefs: Out of sight - no longer out of mind* S. Hain and E. Corcoran (Eds.), (pp. 80). Cambridge, UK: [UNEP-WCMC] United Nations Environment Programme-World Conservation Monitoring Centre. Retrieved from http://www.unep-wcmc.org/resources/publications/UNEP_WCMC_bio_series/22.htm

Galloway, S. B., Bruckner, A. W. & Woodley, C. M. (Eds.). (2009). *Coral Health and Disease in the Pacific: Vision for Action*. (NOAA Technical Memorandum NOS NCCOS 97 and CRCP 7, pp. 314). Silver Spring, MD: National Oceanic and Atmospheric Administration.

Gaspin, J. B., Wiley, M. L. & Peters, G. B. (1976). Experimental investigations of the effects of underwater explosions on swimbladder fish, II: 1975 Chesapeake Bay tests. Silver Spring, Maryland: White Oak Laboratory.

Glynn, P. W. (1976). Some physical and biological determinants of coral community structure in the eastern Pacific. Ecology Monographs. 46:431-456.

Glynn, P. W. (1993). Coral reef bleaching: ecological perspectives. *Coral Reefs, 12*(1), 1-17.

Gochfeld, D. J. (2004). Predation-induced morphological and behavioral defenses in a hard coral: implications for foraging behavior of coral-feeding butterflyfishes. *Marine Ecology-Progress Series, 267*, 145-158.

Gooday, A. J. (2008). New organic-walled Foraminifera (Protista) from the ocean's deepest point, the Challenger Deep (western Pacific Ocean). *Zoological Journal of the Linnean Society*, 153(3), 399-423.

Gulko, D. (1998). The Corallivores: The crown-of-thorns sea star (*Acanthaster planci*). In *Hawaiian Coral Reef Ecology* (pp. 101-102). Honolulu, HI: Mutual Publishing.

Heberholz, J. & Schmitz, B. A. (2001). Signaling via water currents in behavioral interactions of snapping shrimp (*Alpheus heterochaelis*). *Biological Bulletin, 201*, 6-16.

Heithaus, M. R., McLash, J. J., Frid, A., Dill, L. M. & Marshall, G. (2002). Novel insights into green sea turtle behaviour using animal-borne video cameras. *Journal of the Marine Biological Association of the United Kingdom, 82*(6), 1049-1050.

Hoeksema, B., Rogers, A. & Quibilan, M. (2008a). Pavona diffluens. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1

Hoeksema, B., Rogers, A. & Quibilan, M. (2008b). *Pachyseris rugosa*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Hoeksema, B., Rogers, A. & Quibilan, M. (2008c). *Pocillopora danae*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Hoeksema, B., Rogers, A. & Quibilan, M. (2008d). *Pocillopora elegans*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Hoeksema, B., Rogers, A. & Quibilan, M. (2008e). *Seriatopora aculeata*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Hoover, J. P. (1998a). Bryozoans: Phylum *Byrozoa (or Ectoprocta)*. In *Hawai'i's Sea Creatures: A Guide to Hawai'i's Marine Invertebrates* (pp. 87-91). Honolulu, HI: Mutual Publishing.

Hoover, J. P. (1998b). Echinoderms: Phylum *Echinodermata.* In *Hawai'i's Sea Creatures: A Guide to Hawai'i's Marine Invertebrates* (pp. 290-335). Honolulu, HI: Mutual Publishing.

Hoover, J. P. (1998c). *Hawai'i's Sea Creatures: A Guide to Hawaii's Marine Invertebrates*. Honolulu, HI: Mutual Publishing.

Hu, Y. H., H. Y. Yan, W. S. Chung, J.C. Shiao, & P. P. Hwang. (2009). Acoustically evoked potentials in two cephalopods inferred using the auditory brainstem response (ABR) approach*. Comparative Biochemistry and Physiology, Part A 153*:278–283.

Hughes, T. P. & Connell, J. H. (1999). Multiple stressors on coral reefs: A long-term perspective. *Limnology and Oceanography, 44*(3 II), 932-940. Retrieved from http://www.scopus.com/scopus/inward/record.url?eid=2-s2.0-0032933347&partnerID=40

Hughes, T. P., Baird, A. H., Bellwood, D. R., Card, M., Connolly, S. R., Folke, C., Roughgarden, J. (2003). Climate change, human impacts, and the resilience of coral reefs. *Science, 301*(5635), 929-933.

Jackson, J. B. C. (2008). Ecological extinction and evolution in the brave new ocean. *Proceedings of the National Academy of Sciences of the United States of America, 105*(SUPPL. 1), 11458-11465.

Jackson, J. B. C., Kirby, M. X., Berger, W. H., Bjorndal, K. A., Botsford, L. W., Bourque, B. J., Warner, R. R. (2001). Historical overfishing and the recent collapse of coastal ecosystems. *Science, 293*(5530), 629-638.

James, M. C. & Herman, T. B. (2001). Feeding of *Dermochelys coriacea* on medusae in the northwest Atlantic. *Chelonian Conservation and Biology, 4*(1), 202-205.

Jeffs, A., Tolimieri, N. & Montgomery, J. C. (2003). Crabs on cue for the coast: the use of underwater sound for orientation by pelagic crab stages. *Marine and Freshwater Research, 54*, 841-845.

Jennings, S. & Kaiser, M. J. (1998). The effects of fishing on marine ecosystems A. J. S. J.H.S. Blaxter and P. A. Tyler (Eds.), *Advances in Marine Biology* (Vol. Volume 34, pp. 201-352). Academic Press.

Kaifu, K., Akamatsu, T. & Segawa, S. (2008). Underwater sound detection by cephalopod statocyst. *Fisheries Science, 74*, 781-786. 10.1111/j.1444-2906.2008.01589.x

Kaiser, M. J., Collie, J. S., Hall, S. J., Jennings, S. & Poiner, I. R. (2002). Modification of marine habitats by trawling activities: Prognosis and solutions. *Fish and Fisheries, 3*(2), 114-136. 10.1046/j.1467-2979.2002.00079.x

Kelly, M., J. Hooper, V. Paul, G. Paulay, R. van Soest, and W. de Weerdt. (2003). Taxonomic inventory of the sponges (Porifera) of Mariana Islands. Micronesica 35-36:100-120.

Kinch, J., Purcell, S., Uthicke, S., & Friedman, K. (2008). Population status, fisheries and trade of sea cucumbers in the Western Central Pacific. In V. Toral-Granda, A. Lovatelli and M. Vasconcellos. Sea cucumbers. A global review of fisheries and trade. FAO Fisheries and Aquaculture Technical Paper. No. 516. Rome, FAO. pp. 7–55

Lagardère, J.-P. (1982). Effects of noise on growth and reproduction of *Crangon crangon* in rearing tanks. *Marine Biology, 71*, 177-185.

Lagardère, J.-P. & Régnault, M. R. (1980). Influence du niveau sonore de bruit ambient sur la métabolisme de *Crangon crangon* (Decapoda: Natantia) en élevage. *Marine Biology, 57*, 157-164.

Latha, G., Senthilvadivu, S., Venkatesan, R. & Rajendran, V. (2005). Sound of shallow and deep water lobsters: Measurements, analysis, and characterization (L). *Journal of the Acoustical Society of America, 117*, 2720-2723.

Levinton, J. (2009). *Marine Biology: Function, Biodiversity, Ecology* (3rd ed.). New York: Oxford University Press.

Lindholm, J., Gleason, M., Kline, D., Clary, L., Rienecke, S. & Bell, M. (2011). Trawl Impact and Recovery Study: 2009-2010 Summary Report. (pp. 39) California Ocean Protection Council.

Lirman, D. (2000). Fragmentation in the branching coral *Acropora palmata* (Lamarck): growth, survivorship, and reproduction of colonies and fragments. *Journal of Experimental Marine Biology and Ecology, 251*, 41-57.

Lovell, J. M., Findlay, M. M., Moate, R. M. & Yan, H. Y. (2005). The hearing abilities of the prawn *Palaemon serratus*. *Comparative Biochemistry and Physiology Part A, 140*, 89-100.

Lovell, J. M., Moate, R. M., Christiansen, L. & Findlay, M. M. (2006). The relationship between body size and evoked potentials from the statocysts of the prawn *Palaemon serratus*. *The Journal of Experimental Biology, 209*, 2480-2485.

Mackie, G. O. & Singla, C. L. (2003). The Capsular Organ of *Chelyosoma productum* (Ascidiacea: Corellidae): A New Tunicate Hydrodynamic Sense Organ. *Brain, Behavior and Evolution, 61*, 45-58.

Macpherson, E. (2002). Large–scale species–richness gradients in the Atlantic Ocean. *Proceedings of the Royal Society of London. Series B: Biological Sciences, 269*(1501), 1715-1720. doi: 10.1098/rspb.2002.2091

Mato, Y., Isobe, T., Takada, H., Kanehiro, H., Ohtake, C. & Kaminuma, T. (2001). Plastic resin pellets as a transport medium for toxic chemicals in the marine environment. *Environmental Science and Technology, 35*(2), 318-324. 10.1021/es0010498

McCauley, R. D., Fewtrell, J., Duncan, A. J., Jenner, C., Jenner, M.-N., Penrose, J. D., McCabe, K. (2000a). Marine seismic surveys: analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. (REPORT R99-15) Centre for Marine Science and Technology, Curtin University.

McCauley, R. D., Fewtrell, J., Duncan, A. J., Jenner, C., Jenner, M. N., Penrose, J., McCabe, K. (2000b). Marine seismic surveys - A study of environmental implications. *APPEA Journal*, 692-708.

Mintz, J. D. & Parker, C. L. (2006). *Vessel Traffic and Speed Around the U. S. Coasts and Around Hawaii* [Final report]. (CRM D0013236.A2, pp. 48). Alexandria, VA: CNA Corporation.

Montgomery, J. C., Jeffs, A., Simpson, S. D., Meekan, M. G. & Tindle, C. (2006). Sound as an Orientation Cue for the Pelagic Larvae of Reef Fishes and Decapod Crustaceans. *Advances in Marine Biology, 51*.

Mooney, T. A., Hanlon, R. T., Christensen-Dalsgaard, J., Madsen, P. T., Ketten, D. & Nachtigall, P. E. (2010). Sound detection by the longfin squid (*Loligo pealeii*) studied with auditory evoked potentials: sensitivity to low-frequency particle motion and not pressure. *The Journal of Experimental Biology, 213*, 3748-3759.

National Marine Fisheries Service. (2010a). Endangered and threatened wildlife; notice of 90–day finding on a petition to list 83 species of corals as threatened or endangered under the Endangered Species Act (ESA). *Federal Register, 75*(27), 6616-6621.

National Marine Fisheries Service. (2010b). *Marine Invertebrates and Plants*. [Web page] National Oceanic and Atmospheric Administration, Office of Protected Resources. Retrieved from http://www.nmfs.noaa.gov/pr/species/invertebrates/, 22 November 2011.

National Marine Fisheries Service. (2010c). *Deep Sea Corals*. [Web page] National Oceanic and Atmospheric Administration, Office of Oceanic and Atmospheric Research. Retrieved from http://www.oar.noaa.gov/oceans/t_deepseacorals.html, 8 September 2010.

National Marine Fisheries Service. (2012). Management Report for 82 Corals Status Review under the Endangered Species Act. March 2012 DRAFT.

National Oceanic and Atmospheric Administration. (2010a). *NOAA to review status of 82 species of coral*. St. Petersburg, FL.

National Oceanic and Atmospheric Administration. (2010b). *Oil Spills in Coral Reefs: Planning & Response Considerations*. (pp. 80). Silver Spring, MD: U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration, Hazardous Materials Response Division.

National Oceanic and Atmospheric Administration & U.S. Department of Commerce. (2010). *Implementation of the Deep Sea Coral Research and Technology Program 2008 - 2009* [Report to Congress]. (pp. 65). Silver Spring, MD: NOAA Coral Reef Conservation Program, National Marine Fisheries Service. Available from http://www.nmfs.noaa.gov/habitat/2010_deepcoralreport.pdf

Negri, A. P., Smith, L. D., Webster, N. S. & Heyward, A. J. (2002). Understanding ship-grounding impacts on a coral reef: potential effects of anti-foulant paint contamination on coral recruitment. Marine Pollution Bulletin, 44(2), 111-117. doi: 10.1016/s0025-326x(01)00128-x

Newman, L. J., Paulay, G. & Ritson-Williams, R. (2003). Checklist of polyclad flatworms (Platyhelminthes) from Micronesian coral reefs. 189-199.

Norström, A. V., Nyström, M., Lokrantz, J. & Folke, C. (2009). Alternative states on coral reefs: Beyond coral-macroalgal phase shifts. *Marine ecology progress series, 376*, 293-306.

O'Keefe, D. J. & Young, G. A. (1984). Handbook on the environmental effects of underwater explosions. (pp. 203). Prepared by Naval Surface Weapons Center.

Obura, D., Fenner, D., Hoeksema, B., Devantier, L. & Sheppard, C. (2008). Millepora foveolata. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Ocean Conservancy. (2010). Trash travels: from our hands to the sea, around the globe, and through time C. C. Fox (Ed.), *International Coastal Cleanup report*. (pp. 60) The Ocean conservancy.

Packard, A., Karlsen, H. E. & Sand, O. (1990). Low frequency hearing in cephalopods. *Journal of Comparative Physiology A, 166*, 501-505.

Pait, A. S., Mason, A. L., Whitall, D. R., Christensen, J. D. & Hartwell, S. I. (2010). Chapter 5: Assessment of Chemical Contaminants in Sediments and Corals in Vieques L. J. Bauer and M. S. Kendall (Eds.), An

Ecological Characterization of the Marine Resources of Vieques, Puerto Rico. (pp. 101-150). Silver

Spring, MD: NOAA MCCOS 110.

Pandolfi, J. M., Bradbury, R. H., Sala, E., Hughes, T. P., Bjorndal, K. A., Cooke, R. G., Jackson, J. B. C. (2003). Global trajectories of the long-term decline of coral reef ecosystems. *Science, 301*(5635), 955-958.

Parry, G. D. & Gason, A. (2006). The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia. *Fisheries Research, 79*, 272-284.

Patek, S. N. & Caldwell, R. L. (2006). The stomatopod rumble: Low frequency sound production in *Hemisquilla californiensis*. *Marine and Freshwater Behaviour and Physiology, 39*(2), 99-111.

Patek, S. N., Shipp, L. E. & Staaterman, E. R. (2009, May). The acoustics and acoustic behavior of the California spiny lobster (*Panulirus interruptus*). *Journal of the Acoustical Society of America, 125*(5), 3434-3443.

Pauly, D., Christensen, V., Guenette, S., Pitcher, T. J., Sumaila, U. R., Walters, C. J., Zeller, D. (2002). Towards sustainability in world fisheries. Nature, 418(6898), 689-695. doi: 10.1038/nature01017

Paulay, G. (2003a). Marine biodiversity of Guam and the Marianas: Overview. Micronesica 35-36:3-25.

Paulay, G. (2003b). Marine bivalvia (Mollusca) of Guam. Micronesica 35-36:218-243.

Paulay, G. (2003c). Miscellaneous marine invertebrates and protists from the Mariana Islands. Micronesica 35-36:676-682.

Paulay, G. (2003d). The Asteroidea, Echinoidea, and Holothuroidea (Echinodermata) of the Mariana Islands. Micronesica 35-36:563-583.

Paulay, G., R. Knopp, P.K.L. Ng, and L.G. Eldredge. (2003a). The crustaceans and pycnogonids of the Mariana Islands. Micronesica 35-36:456-513.

Paulay, G., M.P. Puglisi, and J.A. Starmer. (2003b). The non-scleractinian Anthozoa (Cnidaria) of the Mariana Islands. Micronesica 35-36:138-155.

Payne, J. F., Andrews, C. A., Fancey, L. L., Cook, A. L. & Christian, J. R. (2007). Pilot Study on the Effects of Seismic Air Gun Noise on Lobster (Homarus Americanus).

Pearson, W. H., Skalski, J. R., Sulkin, S. D. & Malme, C. I. (1993). Effects of Seismic Energy Releases on the Survival and Development of Zoeal Larvae of Dungeness Crab (*Cancer magister*). *Marine Environment Research, 38*, 93-113.

Perea-Blázquez A, Davy SK, Bell JJ. (2012). Estimates of Particulate Organic Carbon Flowing from the Pelagic Environment to the Benthos through Sponge Assemblages. PLoS ONE 7(1): e29569. doi:10.1371/journal.pone.0029569

Popper, A. N., Salmon, M. & Horch, K. W. (2001). Acoustic detection and communication by decapod crustaceans. *Journal of Comparative Physiology A, 187*, 83-89.

Porter, J. W., Dustan, P., Jaap, W. C., Patterson, K. L., Kosmynin, V., Meier, O. W., . . . Parsons, M. (2001). Patterns of spread of coral disease in the Florida Keys. Hydrobiologia, 460, 1-24. doi: 10.1023/A:1013177617800

Precht, W. F., Aronson, R. B. & Swanson, D. W. (2001). Improving scientific decision-making in the restoration of ship-grounding sites on coral reefs. *Bulletin of Marine Science, 69*(2), 1001-1012.

Radford, C., Jeffs, A. & Montgomery, J. C. (2007). Directional swimming behavior by five species of crab postlarvae in response to reef sound. *Bulletin of Marine Science, 80*(2), 369-378.

Radford, C., Stanley, J., Tindle, C., Montgomery, J. C. & Jeffs, A. (2010, 22 February). Localised coastal habitats have distinct underwater sound signatures. *Marine Ecology Progress Series, 401*, 21-29.

Randall, R.H. (2003). An annotated checklist of hydrozoan and scleractinian corals collected from Guam and other Mariana Islands. Micronesica 35-36:121-137.

Richards, Z., Delbeek, J.C., Lovell, E., Bass, D., Aeby, G. & Reboton, C. (2008a). *Acropora globiceps*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1

Richards, Z., Delbeek, J.C., Lovell, E., Bass, D., Aeby, G. & Reboton, C. (2008b). *Acropora listeri*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Richards, Z., Delbeek, J.C., Lovell, E., Bass, D., Aeby, G. & Reboton, C. (2008c). *Acropora microclados*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Richards, Z., Delbeek, J.C., Lovell, E., Bass, D., Aeby, G. & Reboton, C. (2008d). *Acropora polystoma*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Richards, Z., Delbeek, J.C., Lovell, E., Bass, D., Aeby, G. & Reboton, C. (2008e). *Acropora vaughani*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Richards, Z., Delbeek, J.C., Lovell, E., Bass, D., Aeby, G. & Reboton, C. (2008f). *Acropora verweyi*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Richards, Z., Delbeek, J.C., Lovell, E., Bass, D., Aeby, G. & Reboton, C. (2008g). *Anacropora puertogalerae*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Richardson, S. L. & R. N. Clayshulte. (2003). An annotated checklist of Foraminifera of Guam. Micronesica 35-36: 38-53.

Richmond, R. H. (1997). Reproduction and recruitment in corals: Critical links in the persistence of reefs. In C. Birkeland (Ed.), *Life and Death of Coral Reefs* (pp. 175-197). New York, NY: Chapman and Hall.

Riegl, B. & Branch, G. M. (1995). Effects of sediment on the energy budgets of four scleractinian (Bourne 1900) and five alcyonacean (Lamouroux 1816) corals. *Journal of Experimental Marine Biology and Ecology, 186*(2), 259-275. Retrieved from http://www.scopus.com/scopus/inward/record.url?eid=2-s2.0-0028976427&partnerID=40

Risk, M. (2009). The reef crisis and the reef science crisis: Nitrogen isotopic ratios as an objective indicator of stress. *Marine Pollution Bulletin, 58*(6), 787-788. doi: 10.1016/j.marpolbul.2009.03.021

Rosen, G. & Lotufo, G. R. (2007a). Bioaccumulation of explosive compounds in the marine mussel, *Mytilus galloprovincialis*. *Ecotoxicology and Environmental Safety, 68*, 237–245. doi: 10.1016/j.ecoenv.2007.04.009

Rosen, G. & Lotufo, G. R. (2007b). Toxicity of explosive compounds to the marine mussel, *Mytilus galloprovincialis*, in aqueous exposures. *Ecotoxicology and Environmental Safey, 68*(2), 228-236. doi: 10.1016/j.ecoenv.2007.03.006

Rosen, G. & Lotufo, G. R. (2010). Fate and effects of composition B in multispecies marine exposures. *Environmental Toxicology and Chemistry, 29*(6), 1330-1337. doi: 10.1002/etc.153

Schoeman, D. S., McLachlan, A. & Dugan, J. E. (2000). Lessons from a disturbance experiment in the intertidal zone of an exposed sandy beach. *Estuarine, Coastal and Shelf Science, 50*(6), 869-884. doi: 10.1006/ecss.2000.0612

Schuhmacher, H. & Zibrowius, H. (1985). What is hermatypic? *Coral Reefs, 4*(1), 1-9. doi: 10.1007/BF00302198

Sheppard, A., Fenner, D., Edwards, A., Abrar, M. & Ochavillo, D. (2008a). *Alveopora allingi*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Sheppard, A., Fenner, D., Edwards, A., Abrar, M. & Ochavillo, D. (2008b). *Alveopora fenestrata*. In: IUCN 2013. IUCN Red List of Threatened Species.

Sheppard, A., Fenner, D., Edwards, A., Abrar, M. & Ochavillo, D. (2008c). *Alveopora verrilliana*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Sheppard, A., Fenner, D., Edwards, A., Abrar, M. & Ochavillo, D. (2008d). *Porites horizontalata*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Sheppard, A., Fenner, D., Edwards, A., Abrar, M. & Ochavillo, D. (2008e). *Porites napopora*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Sheppard, A., Fenner, D., Edwards, A., Abrar, M. & Ochavillo, D. (2008f). *Porites nigrescens*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Simpson, S. D., Radford, A. N., Tickle, E. J., Meekan, M. G. & Jeffs, A. (2011). Adaptive Avoidance of Reef Noise. *PLoS ONE, 6*(2).

Singh, B. & Sharma, N. (2008). Mechanistic implications of plastic degradation. *Polymer Degradation and Stability, 93*(3), 561-584. doi: 10.1016/j.polymdegradstab.2007.11.008

South Atlantic Fishery Management Council. (1998). *Final habitat plan for the South Atlantic region: Essential fish habitat requirements for fishery management plans of the South Atlantic Fishery Management Council*. Charleston, SC: South Atlantic Fishery Management Council.

Spalding, M. D., Ravilious, C. & Green, E. P. (2001). *World Atlas of Coral Reefs* (pp. 424). Berkeley, California: University of California Press.

Spargo, B. J. (1999). *Environmental Effects of RF Chaff: A Select Panel Report to the Undersecretary of Defense for Environmental Security* [Final Report]. (NRL/PU/6110- -99-389, pp. 85). Washington, DC: U. S. Department of the Navy, Naval Research Laboratory.

Stanley, J., Radford, C. & Jeffs, A. (2010, January 2010). Induction of settlement in crab megalopae by ambient underwater reef sound. [Journal Article]. *Behavioral Ecology, 21*(1), 113-120.

Swisdak Jr., M. M. & Montaro, P. E. (1992). Airblast and fragmentation hazards produced by underwater explosions. (pp. 35). Silver Springs, Maryland. Prepared by Naval Surface Warfare Center.

Teuten, E. L., Rowland, S. J., Galloway, T. S. & Thompson, R. C. (2007). Potential for plastics to transport hydrophobic contaminants. *Environmental Science and Technology, 41*(22), 7759-7764. doi: 10.1021/es071737s

Turak, E., Sheppard, C. & Wood, E. (2008a). Euphyllia cristata. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Turak, E., Sheppard, C. & Wood, E. (2008b). Euphyllia paraancora. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Turak, E., Sheppard, C. & Wood, E. (2008c). Physogyra lichtensteini. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Turak, E., Sheppard, C. & Wood, E. (2008d). Acanthastrea brevis. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

U.S. Army Corps of Engineers. (2001). Environmental effects of beach nourishment projects. In *The Distribution of Shore Protection Benefits: A Preliminary Examination*. (pp. 67-108). Alexandria, VA: U. S. Army Corps of Engineer Institute for Water Resources.

University of California at Berkeley. (2010a). *Introduction to the Cnidaria: Jellyfish, corals, and other stingers*. Retrieved from http://www.ucmp.berkeley.edu/cnidaria/cnidaria.html

University of California at Berkeley. (2010b). *Introduction to the Platyhelminthes: Life in two dimensions*. Retrieved from http://www.ucmp.berkeley.edu/platyhelminthes/platyhelminthes.html, 8 September 2010.

van Oppen, M. J. H. & Lough, J. M. (Eds.). (2009). *Coral Bleaching: Patterns, Processes, Causes and Consequences* (Vol. 205, pp. 178). Berlin, Heidelberg: Springer-Verlag. Retrieved from http://ezproxy.library.uq.edu.au/login?url=http://dx.doi.org/10.1007/978-3-540-69775-6.

Vermeij, M. J. A., Marhaver, K. L., Huijbers, C. M., Nagelkerken, I. & Simpson, S. D. (2010). Coral larvae move toward reef sounds. *PLoS ONE, 5*(5), e10660. doi:10.1371/journal.pone.0010660

Veron, J. E. N. (2000). Corals of the World. Australian Institute of Marine Science. Townsville, Australia

Veron, JEN and Stafford-Smith, MG. (2011). Coral ID. www.coralid.com version 1.1. Aust. Inst. Mar. Sci.

Waikiki Aquarium. (2009a, Last updated September 2009). *Marine Life Profile: Ghost Crab*. [Fact sheet]. Retrieved from http://www.waquarium.org/marinelifeprofiles_ed.html, 14 June 2010.

Waikiki Aquarium. (2009b, Last updated September 2009). *Marine Life Profile: Hawaiian Slipper Lobsters*. [Fact sheet]. Retrieved from http://www.waquarium.org/marinelifeprofiles_ed.html, 15 June 2010.

Waikiki Aquarium. (2009c, Last updated September 2009). *Marine Life Profile: Hawaiian Spiny Lobster*. [Fact sheet]. Retrieved from http://www.waquarium.org/marinelifeprofiles_ed.html, 15 June 2010.

Western Pacific Regional Fishery Management Council. (2001). *Final Fishery Management Plan for Coral Reef Ecosystems of the Western Pacific Region*. (Vol. 1, pp. 20). Honolulu, HI.

Western Pacific Regional Fishery Management Council. (2009). *Fishery Ecosystem Plan for the Hawaii Archipelago*. (pp. 266). Honolulu, HI.

Wetmore, K. L. (2006, Last updated 14 August 1995). *Introduction to the Foraminifera*. [Web page] University of California Museum of Paleontology. Retrieved from http://www.ucmp.berkeley.edu/foram/foramintro.html, 13 September 2010.

Wilkinson, C. (2002). Executive Summary. In C. Wilkinson (Ed.), *Status of Coral Reefs of the World: 2002* (pp. 7-31). Global Coral Reef Monitoring Network.

Wilkinson, C. (ed.). (2004). Status of coral reefs of the world: 2004. Volume 1. Australian Institute of Marine Science, Townsville, Queensland, Australia. 301 p.

Wood, J. B. & Day, C. L. (2005). *CephBase*. [Online database]. Retrieved from http://www.cephbase.utmb.edu/, 3 June 2005.

Young, G. A. (1991). Concise methods for predicting the effects of underwater explosions on marine life (pp. 1-12). Silver Spring: Naval Surface Warfare Center.

3.9 Fish

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

There are no figures in this section.

3.9 FISH

FISH SYNOPSIS

The United States Department of the Navy considered all potential stressors, and the following have been analyzed for fish:

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

Preferred Alternative (Alternative 1)

- There are no marine fish in the Study Area listed as threatened or endangered under the Endangered Species Act.
- Although potential impacts to certain fish species from the training and testing activities in the Mariana Islands Training and Testing Study Area may include injury or mortality, impacts are not expected to decrease the overall fitness of any given population.
- Pursuant to the Essential Fish Habitat (EFH) requirements, the use of sonar and other active acoustic sources, underwater explosives, and electromagnetic devices may have a minimal and temporary adverse effect on the fishes that occupy water column EFH.

3.9.1 INTRODUCTION

This section analyzes the potential impacts of the Proposed Action on fish found in the Mariana Islands Training and Testing (MITT) Study Area (Study Area) and provides a synopsis of the United States (U.S.) Department of the Navy's (Navy's) determinations of the impacts of the Proposed Action on fish. Section 3.9.1 (Introduction) introduces the Endangered Species Act (ESA) species and taxonomic groups that occur in the Study Area. Section 3.9.2 (Affected Environment) discusses the baseline affected environment. The complete analysis of environmental consequences is in Section 3.9.3 (Environmental Consequences) and the potential impacts of the Proposed Action on fish are summarized in Section 3.9.4 (Summary of Potential Impacts on Fish).

For this Environmental Impact Statement (EIS)/Overseas EIS (OEIS), marine fishes are evaluated as groups of species characterized by either distribution, morphology (body type), or behavior relevant to the stressor being evaluated in Section 3.9.4 (Environmental Consequences). Activities are evaluated for their potential effect on all fishes in general.

Marine fish species that are regulated under Magnuson-Stevens Fishery Conservation and Management Act are discussed in Section 3.9.1.3 (Federally Managed Species). Additional general information on the biology, life history, distribution, and conservation of marine fishes can be found on the following websites, as well as many others:

- National Marine Fisheries Services (NMFS), Office of Protected Resources (including ESA-listed species distribution maps)
- Regional Fishery Management Councils
- International Union for Conservation of Nature
- Essential Fish Habitat (EFH) Text Descriptions

Fishes are not distributed uniformly throughout the Study Area but are closely associated with a variety of habitats. Some species, such as large sharks, salmon, tuna, and billfishes, range across thousands of square miles; others, such as gobies and reef fishes, have small home ranges and restricted distributions (Helfman et al. 2009). The movements of some open-ocean species may never overlap with coastal fishes that spend their lives within several hundred feet of the shore. The distribution and specific habitats in which an individual of a single fish species occurs may be influenced by its developmental stage, size, sex, reproductive condition, and other factors. There are approximately 1,106 marine fish species in the coastal zone of the Study Area (Myers and Donaldson 2003).

For analyses of impacts on those habitats included as EFH within the Study Area, refer to Sections 3.3 (Marine Habitats), 3.7 (Marine Vegetation), and 3.8 (Marine Invertebrates).

3.9.1.1 Endangered Species Act Species

There are no marine fish in the Study Area listed as threatened or endangered under the ESA; however, one species is proposed for listing as threatened, two species are listed as a candidate that may be listed as threatened or endangered in the future, and one species is listed as a species of concern. The NMFS has some concerns regarding status and threats for species of concern, but insufficient information is available to indicate a need to list the species under the ESA. Species of concern status does not carry any procedural or substantive protections under the ESA. Marine fishes listed under the ESA as proposed, candidate species, and species of concern are listed in Table 3.9-1. All the species listed in Table 3.9-1 have been on decline because of impacts from fishing (including night spear fishing, bycatch, and illegal fishing activities) and habitat degradation.

Table 3.9-1: Fish Candidate and Species of Concern in the Mariana Islands Training and Testing Study Area

Species Name and Regulatory Status			Presence in Study Area	
Common Name	Scientific Name	Endangered Species Act Status	Open Ocean	Coastal Ocean
Scalloped Hammerhead Shark	*Sphyrna lewini*	Proposed Threatened	Yes	Yes
Humpheaded wrasse	*Cheilinus undulatus*	Candidate Species	No	Yes
Great Hammerhead Shark	*Sphyrna mokarran*	Candidate Species	Yes	Yes
Bumphead parrotfish	*Bolbometopon muricatum*	Species of Concern	No	Yes

3.9.1.2 Taxonomic Groups

Groups of marine fish are provided in Table 3.9-2 and are described further in Section 3.9.2 (Affected Environment). These fish groups are based on the organization presented in Helfman et al. (1997), Moyle and Cech (1996), and Nelson (2006). These groupings are intended to organize the extensive and diverse list of fish that occur in the Study Area, as a means to structure the analysis of potential impacts to fish with similar ecological niches, behavioral characteristics, and habitat preferences. Exceptions to these generalizations exist within each group, and are noted wherever appropriate in the analysis of potential impacts.

Table 3.9-2: Major Taxonomic Groups of Marine Fishes within the Mariana Islands Training and Testing Study Area

Major Marine Fish Groups[1]		Vertical Distribution Within Study Area	
Common Name (Taxonomic Group)	**Description**	**Open Ocean**	**Coastal Waters**
Jawless fishes (order Myxiniformes and order Petromyzontiformes)	Primitive fishes with an eel-like body shape that feed on dead fishes or are parasitic on other fishes	Water column, seafloor	Seafloor
Sharks, skates, rays, and chimaeras (class Chondrichthyes)	Cartilaginous (non-bony) fishes, many of which are open-ocean predators	Surface, water column, seafloor	Surface, water column, seafloor
Eels and bonefishes (order Anguilliformes, order Elopiformes)	Undergo a unique willow leaf-shaped larval stage with a small head and often an elongated body; very different from other fishes	Surface, water column, seafloor	Surface, water column, seafloor
Herrings (order Clupeiformes)	Commercially valuable schooling plankton eaters such as herrings, sardines, menhaden, and anchovies	Surface, water column	Surface, water column
Dragonfishes and lanternfishes (orders Stomiiformes and Myctophiformes)	Largest group of deepwater fishes, some have adaptations for low-light conditions	Water column, seafloor	Water column, seafloor
Greeneyes, lizardfishes, lancetfishes, and telescopefishes (order Aulopiformes)	Have both primitive and advanced features of marine fishes; includes both coastal and estuarine species, as well as deepsea fish that occur in midwaters and along the bottom.	Seafloor	Water column, seafloor
Cods (orders Gadiformes and Ophidiiformes)	Are associated with bottom habitats, also includes some deepwater groups. Most have a distinctive barbel (a slender tactile organ) below the mouth.	Water column, seafloor	Water column, seafloor
Toadfishes and anglerfishes (orders Batrachoidiformes and Lophiiformes)	Includes the sound-producing toadfishes and the anglerfishes, a classic lie-in-wait predator	Seafloor	Seafloor
Mullets, silversides, and needlefishes (orders Mugiliformes, Atheriniformes, and Beloniformes)	Small-sized nearshore/coastal fishes (within 3 nm of shoreline), primarily feed on organic debris; also includes the surface-oriented flyingfishes	Surface	Surface, water column, seafloor
Oarfishes, squirrelfishes, dories (orders Lampridiformes, Beryciformes, Zeiformes)	Primarily open-ocean or deepwater fishes, except for squirrelfishes (reef-associated)	Surface, water column, seafloor	Surface, water column, seafloor

Table 3.9-2: Major Taxonomic Groups of Marine Fishes within the Mariana Islands Training and Testing Study Area (continued)

Major Marine Fish Groups[1]		Vertical Distribution Within Study Area	
Common Name (Taxonomic Group)	**Description**	**Open Ocean**	**Coastal Waters**
Pipefishes and seahorses (order Gasterosteiformes)	Small mouth with tubular snout and armor like scales; males care for young in nests or pouches	-	Surface, water column, seafloor
Scorpionfishes (order Scorpaeniformes)	Bottom dwelling with modified pectoral fins to rest on the bottom. Many are venomous.	Seafloor	Seafloor
Snappers, drums, and croakers (families Sciaenidae and Lutjanidae)	Important gamefishes and common predators in all marine waters; sciaenids produce sounds with their swim bladders	Surface, water column, seafloor	Surface, water column, seafloor
Groupers and seabasses (order Perciformes,[2] with representative families; Serranidae)	Important gamefish with vulnerable conservation status; in some species, individuals change from female to male as they mature.	Water column, seafloor	Surface, water column, seafloor
Wrasses, damselfishes (family Pomacentridae), and parrotfishes (families Labridae and Scaridae)	Primarily reef-associated fish; in some species, individuals change from female to make as they mature.	-	Surface, water column, seafloor
Gobies and blennies (families Gobiidae and Blennidae)	Gobies are the largest and most diverse family of marine fish, mostly found in bottom habitats of coastal areas.	Surface, water column, seafloor	Surface, water column, seafloor
Jacks, tunas, mackerels, and billfish (order Perciformes,[2] with representative families: Carangidae, Scombridae, Xiphiidae, and Istiophoridae)	Highly migratory predators found near the surface; commercially valuable fisheries.	Surface, water column, seafloor	Surface, water column
Flounders (order Pleuronectiformes)	Flatfish lack swim bladders, are well camouflaged, and occur in bottom habitats throughout the world.	Seafloor	Seafloor
Triggerfishes, puffers, and molas (order Tetraodontiformes)	Unique body shapes and characteristics to deter predators (e.g., spines); includes ocean sunfish, the largest bony fish	Surface, water column, seafloor	Surface, water column, seafloor

[1] Taxonomic groups are based on the following commonly accepted references (Moyle and Cech 1996; Helfman et al. 1997; Nelson 2006).
[2] Order Perciformes includes approximately 40 percent of all bony fish and includes highly diverse fish. Representative families are included here to reflect this diversity.
Notes: Study Area = Mariana Islands Training and Testing Study Area, nm = nautical miles

3.9.1.3 Federally Managed Species

The fisheries of the United States are managed within a framework of overlapping international, federal, state, interstate, and tribal authorities. Individual states and territories generally have jurisdiction over fisheries in marine waters within 3 nautical miles (nm) (12 nm for territories) of their coast. Federal jurisdiction includes fisheries in marine waters inside the U.S. Exclusive Economic Zone, which encompasses the area from the outer boundary of state or territorial waters out to 200 nm offshore of any U.S. coastline, except where intersected closer than 200 nm by bordering countries (National Oceanic and Atmospheric Administration 1996).

The Magnuson-Stevens Fishery Conservation and Management Act and Sustainable Fisheries Act (see Section 3.0.1.1, Federal Statutes) led to the formation of eight fishery management councils that share authority with NMFS to manage and conserve the fisheries in federal waters. Essential Fish Habitat is also identified and managed under this act. For analyses of impacts on those habitats included as EFH within the Study Area, refer to Sections 3.3 (Marine Habitats), 3.7 (Marine Vegetation), and 3.8 (Marine Invertebrates). Together with NMFS, the councils maintain fishery management plans for species or species groups to regulate commercial and recreational fishing within their geographic regions. The Study Area is under the jurisdiction of the Western Pacific Regional Fishery Management Council.

Federally managed marine fish species are listed in Table 3.9-3. These species are included in the list of fish in Table 3.9-3, but are also given consideration as recreationally and commercially important species in the analysis of impacts in Section 3.9.3 (Environmental Consequences). The analysis of impacts on commercial and recreational fisheries is provided in Section 3.12 (Socioeconomic Resources).

Table 3.9-3: Federally Managed Fish Species within the Mariana Islands Testing and Training Study Area, Listed under Each Fishery Management Unit

Western Pacific Regional Fishery Management Council	
Marianas Bottomfish Management Unit	
Common Name	**Scientific Name**
Amberjack	*Seriola dumerili*
Black trevally/jack	*Caranx lugubris*
Blacktip grouper	*Epinephelus fasciatus*
Blueline snapper	*Lutjanus kasmira*
Giant trevally/jack	*Caranx ignobilis*
Gray snapper	*Aprion virescens*
Lunartail grouper	*Variola louti*
Pink snapper	*Pristipomoides filamentosus*
Pink snapper	*Pristipomoides flavipinnis*
Red snapper/silvermouth	*Aphareus rutilans*
Red snapper/buninas agaga	*Etelis carbunculus*
Red snapper/buninas	*Etelis coruscans*
Redgill emperor	*Lethrinus rubrioperculatus*
Snapper	*Pristipomoides zonatus*
Yelloweye snapper	*Pristipomoides flavipinnis*
Yellowtail snapper	*Pristipomoides auricilla*
Marianas Coral Reef Ecosystem Management Unit	
Banded goatfish	*Parupeneus spp.*
Bantail goatfish	*Upeneus arge*
Barred flag-tail	*Kuhlia mugil*
Barred thicklip	*Hemigymnus fasciatus*
Bigeye	*Priacanthus hamrur*
Bigeye scad	*Selar crumenophthalmus*

Table 3.9-3: Federally Managed Fish Species within the Mariana Islands Testing and Training Study Area, Listed under Each Fishery Management Unit (continued)

Western Pacific Regional Fishery Management Council	
Marianas Coral Reef Ecosystem Management Unit (continued)	
Common Name	**Scientific Name**
Bignose unicornfish	*Naso vlamingii*
Bigscale soldierfish	*Myripristis berndti*
Black tongue unicornfish	*Naso hexacanthus*
Black triggerfish	*Melichthys niger*
Blackeye thicklip	*Hemigymnus melapterus*
Blackstreak surgeonfish	*Acanthurus nigricauda*
Blacktip reef shark	*Carcharhinus melanopterus*
Blotcheye soldierfish	*Myripristis murdjan*
Blue-banded surgeonfish	*Acanthurus lineatus*
Blue-lined squirrelfish	*Sargocentron tiere*
Bluespine unicornfish	*Naso unicornus*
Brick soldierfish	*Myripristis amaena*
Bronze soldierfish	*Myripristis adusta*
Cigar wrasse	*Cheilio inermis*
Clown triggerfish	*Balistoides conspicillum*
Convict tang	*Acanthurus triostegus*
Crown squirrelfish	*Sargocentron diadema*
Dash-dot goatfish	*Parupeneus barberinus*
Dogtooth tuna	*Gymnosarda unicolor*
Doublebar goatfish	*Parupeneus bifasciatus*
Engel's mullet	*Moolgarda engeli*
Floral wrasse	*Cheilinus chlorourus*
Forktail rabbitfish	*Siganus aregentus*
Fringelip mullet	*Crenimugil crenilabis*
Galapagos shark	*Carcharhinus galapagensis*
Giant moray eel	*Gymnothorax javanicus*
Glasseye	*Heteropriacanthus cruentatus*
Golden rabbitfish	*Siganus guttatus*
Gold-spot rabbitfish	*Siganus punctatissimus*
Gray unicornfish	*Naso caesius*
Great barracuda	*Sphyraena barracuda*
Grey reef shark	*Carcharhinus amblyrhynchos*
Heller's barracuda	*Sphyraena helleri*
Humphead parrotfish	*Bolbometopon muricatum*
Humpnose unicornfish	*Naso tuberosus*
Longface wrasse	*Hologynmosus doliatus*

Table 3.9-3: Federally Managed Fish Species within the Mariana Islands Testing and Training Study Area, Listed under Each Fishery Management Unit (continued)

Western Pacific Regional Fishery Management Council	
Marianas Coral Reef Ecosystem Management Unit (continued)	
Common Name	**Scientific Name**
Mackerel scad	*Decapterus macarellus*
Mimic surgeonfish	*Acanthurus pyroferus*
Multi-barred goatfish	*Parupeneus multifaciatus*
Napoleon wrasse	*Cheilinus undulates*
Orange-spot surgeonfish	*Acanthurus olivaceus*
Orangespine unicornfish	*Naso lituratus*
Orangestriped triggerfish	*Balistapus undulates*
Pacific longnose parrotfish	*Hipposcarus longiceps*
Parrotfish	*Scarus spp.*
Pearly soldierfish	*Myripristis kuntee*
Pinktail triggerfish	*Melichthys vidua*
Razor wrasse	*Xyrichtys pavo*
Red-breasted wrasse	*Cheilinus fasciatus*
Ring-tailed wrasse	*Oxycheilinus unifasciatus*
Ringtail surgeonfish	*Acanthurus blochii*
Rudderfish	*Kyphosus biggibus*
Rudderfish	*Kyphosus cinerascens*
Rudderfish	*Kyphosus vaigienses*
Saber or long jaw squirrelfish	*Sargocentron spiniferum*
Scarlet soldierfish	*Myripristis pralinia*
Scribbled rabbitfish	*Siganus spinus*
Side-spot goatfish	*Parupeneus pleurostigma*
Silvertip shark	*Carcharhinus albimarginatus*
Spotfin squirrelfish	*Neoniphon spp.*
Spotted unicornfish	*Naso brevirostris*
Stareye parrotfish	*Calotomus carolinus*
Striped bristletooth	*Ctenochaetus striatus*
Stripped mullet	*Mugil cephalus*
Surge wrasse	*Thalassoma purpureum*
Tailspot squirrelfish	*Sargocentron caudimaculatum*
Threadfin	*Polydactylus sexfilis*
Three-spot wrasee	*Halicoeres trimaculatus*
Titan triggerfish	*Balistoides viridescens*
Triple-tail wrasee	*Cheilinus trilobatus*
Twospot bristletooth	*Ctenochaetus binotatus*
Undulated moray eel	*Gymnothorax undulatus*
Vermiculate rabbitfish	*Siganus vermiculatus*

Table 3.9-3: Federally Managed Fish Species within the Mariana Islands Testing and Training Study Area, Listed under Each Fishery Management Unit (continued)

Western Pacific Regional Fishery Management Council	
Marianas Coral Reef Ecosystem Management Unit (continued)	
Common Name	**Scientific Name**
Violet soldierfish	*Myripristis violacea*
White-lined goatfish	*Parupeneus ciliatus*
White-spotted surgeonfish	*Acanthurus guttatus*
Whitebar surgeonfish	*Acanthurus leucopareius*
Whitecheek surgeonfish	*Acanthurus nigricans*
Whitemargin unicornfish	*Naso annulatus*
Whitepatch wrasse	*Xyrichtys aneitensis*
Whitetip reef shark	*Triaenodon obesus*
Whitetip soldierfish	*Myripristis vittata*
Yellow goatfish	*Mulloidichthys spp.*
Yellow tang	*Zebrasoma flavescens*
Yellowfin goatfish	*Mulloidichthys vanicolensis*
Yellowfin soldierfish	*Myripristis chryseres*
Yellowfin surgeonfish	*Acanthurus xanthopterus*
Yellowmarfin moray eel	*Gymnothorax flavimarginatus*
Yellowsaddle goatfish	*Parupeneus cyclostomas*
Yellowstripe goatfish	*Mylloidichthys flaviolineatus*
Guam and Northern Mariana Islands Pelagic Fisheries	
Dogtooth tuna	*Gymnosarda unicolor*
Double-lined mackerel	*Grammatorcynus bilineatus*
Kawakawa	*Euthynnus affinis*
Mahi mahi	*Coryphaena hippurus*
Oilfish	*Ruvettus pretiosus*
Pacific blue marlin	*Makaira mazara*
Rainbow runner	*Elagatis bipinnulatus*
Skipjack tuna	*Katsuwonus pelamis*
Wahoo	*Acanthocybium solandri*
Yellowfin tuna	*Thunnus albacares*

3.9.2 AFFECTED ENVIRONMENT

The distribution and abundance of fishes depends greatly on the physical and biological factors of the marine ecosystem, such as salinity, temperature, dissolved oxygen, population dynamics, predator and prey interaction oscillations, seasonal movements, reproduction and life cycles, and recruitment success (the success of an individual reaching a specific size or reproductive stage) (Helfman et al. 2009). A single factor is rarely responsible for the distribution of fish species; more often, a combination of factors is accountable. For example, open-ocean species optimize their growth, reproduction, and survival by tracking gradients of temperature, oxygen, or salinity (Helfman et al. 2009). Another major component in understanding species distribution is the location of highly productive regions, such as frontal zones (i.e., areas where two or more bodies of water with different oceanographic characteristics meet).

These areas concentrate various prey species and their predators and provide visual cues for the location of target species for commercial fisheries (National Marine Fisheries Service 2001).

Environmental variations, such as the Pacific decadal oscillation events (e.g., El Niño or La Niña), change the normal water temperatures in an area which affects the distribution, habitat range, and movement of open-ocean species (Adams et al. 2002; Sabarros et al. 2009; Bakun et al. 2010) within the Study Area. Pacific decadal oscillation events have caused the distribution of fisheries, such as that of the skipjack tuna (*Katsuwonus pelamis*), to shift by more than 620 miles (mi.) (997.8 kilometers [km]) (National Marine Fisheries Service 2001; Stenseth et al. 2002).

Currently 1,106 species of coastal zone fishes are known to occur around the Mariana Islands within the Study Area. The species found in the Study Area include widespread Indo-Pacific species (58 percent), circumtropical species (3.6 percent), Indo-west Pacific and west Pacific species (17.6 percent), west-central Pacific and Pacific Plate species (18.3 percent), and species confined to specific geographic areas, such as Micronesia, the Philippine plate and endemic to the Marianas (2.5 percent) (Myers and Donaldson 2003). Only 10 of the shallow water species found in the Study Area are endemic to the Mariana Islands (Myers and Donaldson 2003) Migratory open-ocean fishes, such as the larger tunas, the billfishes, and some sharks, are able to move across the great distance that separates the Mariana Islands from other islands or continents in the Pacific. Coral reef fish communities in the Mariana Islands tend to show a more consistent pattern of species throughout the year.

3.9.2.1 Hearing and Vocalization

Many researchers have investigated hearing and vocalizations in fish species (e.g., Astrup 1999; Hawkins and Johnstone 1978; Coombs and Popper 1979; Dunning et al. 1992; Astrup and MØHL 1993; Casper et al. 2003; Gregory and Clabburn 2003; Egner and Mann 2005; Casper and Mann 2006; Higgs et al. 2004; Iversen 1967; Iversen 1969; Jørgensen et al. 2005; Kenyon 1996; Meyer et al. 2010; Popper 1981; Popper and Tavolga 1981; Mann et al. 1997; Popper and Carlson 1998; Mann et al. 2001; Myrberg 2001; Ramcharitar et al. 2001; Nestler 2002; Sisneros and Bass 2003; Ramcharitar and Popper 2004; Ramcharitar et al. 2004; Mann et al. 2005; Wright et al. 2005; Ramcharitar et al. 2006; Remage-Healey et al. 2006; Song et al. 2006; Wright et al. 2007; Popper 2008).

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

Although hearing capability data only exist for fewer than 100 of the 32,000 fish species, current data suggest that most species of fish detect sounds from 50 to 1,000 Hz (low frequency), with few fish hearing sounds above 4,000 Hz (mid-frequency) (Popper 2008). It is believed that most fish have their best hearing sensitivity from 100 to 400 Hz (low frequency) (Popper 2003). Additionally, some clupeids (shad in the subfamily Alosinae) possess very high frequency hearing (i.e., able to detect sounds above 100,000 Hz) (Astrup 1999).

The inner ears of fish are directly sensitive to acoustic particle motion rather than acoustic pressure (for a more detailed discussion of particle motion versus pressure, see Section 3.0.4, Acoustic and Explosives Primer). Although a propagating sound wave contains both pressure and particle motion components, particle motion is most significant at low frequencies (less than a few hundred Hz) and closer to the sound source. However, a fish's gas-filled swim bladder can enhance sound detection by converting acoustic pressure into localized particle motion, which may then be detected by the inner ear. Fish with swim bladders generally have better sensitivity and better high-frequency hearing than fish without swim bladders (Popper and Fay 2010). Some fish also have specialized structures such as small gas bubbles or gas-filled projections that terminate near the inner ear. These fish have been called "hearing specialists," while fish that do not possess specialized structures have been referred to as "generalists" (Popper et al. 2003). In reality many fish species possess a continuum of anatomical specializations that may enhance their sensitivity to pressure (versus particle motion), and thus higher frequencies and lower intensities (Popper and Fay 2010).

Past studies indicated that hearing specializations in marine fish were quite rare (Popper 2003; Amoser and Ladich 2005). However, more recent studies have shown that there are more fish species than originally investigated by researchers, such as deep sea fish, that may have evolved structural adaptations to enhance hearing capabilities (Buran et al. 2005; Deng et al. 2011). Marine fish families Holocentridae (squirrelfish and soldierfish), Pomacentridae (damselfish), Gadidae (cod, hakes, and grenadiers), and Sciaenidae (drums, weakfish, and croakers) have some members that can potentially hear mid-frequency sound up to a few kilohertz (kHz). There is also evidence, based on the structure of the ear and the relationship between the ear and the swim bladder, that at least some deep-sea species, including myctophids, may have hearing specializations and thus be able to hear higher frequencies (Popper 1977; Popper 1980; Deng et al. 2011), although it has not been possible to do actual measures of hearing on these fish from great depths.

Several species of reef fish tested have shown sensitivity to mid-frequencies (i.e., over 1000 Hz). The hearing of the shoulderbar soldierfish (*Myripristis kuntee*) has a mid-frequency auditory range extending toward 3 kHz (Coombs and Popper 1979), while other species tested in this family have been demonstrated to lack this mid-frequency hearing ability (e.g., Hawaiian squirrelfish [*Adioryx xantherythrum*] and saber squirrelfish [*Sargocentron spiniferum*]). Some damselfish can hear frequencies of up to 2 kHz, but with best sensitivity well below 1 kHz (Kenyon 1996; Egner and Mann 2005; Wright et al. 2005; Wright et al. 2007).

Sciaenid research by Ramcharitar et al. (2006) investigated the hearing sensitivity of weakfish (*Cynoscion regalis*). Weakfish were found to detect frequencies up to 2 kHz. The sciaenid with the greatest hearing sensitivity discovered thus far is the silver perch (*Bairdiella chrysoura*), which has responded to sounds up to 4 kHz (Ramcharitar et al. 2004). Other species tested in the family Sciaenidae have been demonstrated to lack this mid-frequency sensitivity.

It is possible that the Atlantic cod (*Gadus morhua,* Family: Gadidae) is also able to detect high-frequency sounds (Astrup and Mohl 1993). However, in Astrup and Mohl's (1993) study it is feasible that the cod was detecting the stimulus using touch receptors that were over driven by very intense fish-finding sonar emissions (Astrup 1999; Ladich and Popper 2004). Nevertheless, Astrup and Mohl (1993) indicated that cod have high frequency thresholds of up to 38 kHz at 185 to 200 decibels (dB) referenced to (re) 1 micropascal (µPa), which likely only allows for detection of odontocete's clicks at distances no greater than 33 to 98 feet (ft.) (10.06 to 29.9 meters [m]) (Astrup 1999).Experiments on several species of the Clupeidae (i.e., herrings, shads, and menhadens) have obtained responses to frequencies between 40 kHz and 180 kHz (Astrup 1999); however, not all clupeid species tested have demonstrated this very high-frequency hearing. Mann et al. (1998) reported that the American shad can detect sounds from 0.1 to 180 kHz with two regions of best sensitivity: one from a low-frequency region (0.2 to 0.8 kHz), and the other from a mid-to high-frequency region (25 kHz to 150 kHz). This shad species has relatively high thresholds (about 145 dB re 1 µPa), which should enable the fish to detect odontocete clicks at distances up to about 656 ft. (199.9 m) (Mann et al. 1997). Likewise, other members of the subfamily Alosinae, including Alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), and Gulf menhaden (*Brevoortia patronus*), have upper hearing thresholds exceeding 100 to 120 kHz. In contrast, the Clupeidae bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), and Spanish sardine (*Sardinella aurita*) did not respond to frequencies over 4 kHz (Mann et al. 2001; Gregory and Clabburn 2003). Mann et al. (2005) found hearing thresholds of 0.1 kHz to 5 kHz for Pacific herring (*Clupyea pallasii*).

Two other groups to consider are the jawless fish (Superclass: Agnatha—lamprey) and the cartilaginous fish (Class: Chondrichthyes—the sharks, rays, and chimeras). While there are some lampreys in the marine environment, virtually nothing is known about their hearing capability. They do have ears, but these are relatively primitive compared to the ears of other vertebrates, and it is unknown whether they can detect sound (Popper and Hoxter 1987). While there have been some studies on the hearing of cartilaginous fish, these have not been extensive. However, available data suggest detection of sounds from 20 to 1000 Hz, with best sensitivity at lower ranges (Myrberg 2001; Casper et al. 2003; Casper and Mann 2006; Casper and Mann 2009). It is likely that elasmobranchs only detect low-frequency sounds because they lack a swim bladder or other pressure detector.

Most other marine species investigated to date lack mid-frequency hearing (i.e., greater than 1,000 Hz). This notably includes sturgeon species tested to date that could detect sound up to 400 or 500 Hz (Meyer et al. 2010; Lovell et al. 2005) and Atlantic salmon that could detect sound up to about 500 Hz (Hawkins and Johnstone 1978; Kane et al. 2010).

Bony fish can produce sounds in a number of ways and use them for a number of behavioral functions (Ladich 2008). Over 30 families of fish are known to use vocalizations in aggressive interactions, whereas over 20 families known to use vocalizations in mating (Ladich 2008). Sound generated by fish as a means of communication is generally low-frequency below 500 Hz (Slabbekoorn et al. 2010). The air in the swim bladder is vibrated by the sound producing structures (often muscles that are integral to the swim bladder wall) and radiates sound into the water (Zelick et al. 1999). Sprague and Luczkovich (2004) calculated that silver perch (*Bidyanus bidyanus*) can produce drumming sounds ranging from 128 to 135 dB re 1 µPa. Female midshipman fish (genus Porichthys) apparently use the auditory sense to detect and locate vocalizing males during the breeding season (Sisneros and Bass 2003).

3.9.2.2 General Threats

This section covers the existing condition of marine fish as a resource and presents some of the major threats to that resource within the Study Area. Human impacts are widespread throughout the world's oceans, such that very few habitats remain unaffected by human influence (Halpern et al. 2008). These stressors have shaped the condition of marine fish populations, particularly those species with large body sizes and late maturity ages, because these species are especially vulnerable to habitat losses and fishing pressure (Reynolds et al. 2005). This trend is evidenced by the world's shark species, which make up 60 percent of the marine fishes of conservation concern (International Union for Conservation of Nature 2009). Furthermore, the conservation status of only 3 percent of the world's marine fish species has been evaluated, so the threats to the remaining species are largely unknown at this point (Reynolds et al. 2005).

Overfishing is the most serious threat that has led to the listing of ESA-protected marine species (Kappel 2005; Crain et al. 2009), with habitat loss also contributing to extinction risk (Jonsson et al. 1999; Musick et al. 2000; Dulvy et al. 2003; Cheung et al. 2007; Limburg and Waldman 2009). Approximately 30 percent of the fishery stocks managed by the United States are overfished (U.S. Fish and Wildlife Service and National Marine Fisheries Service 2009). Overfishing occurs when fish are harvested in quantities above a sustainable level. Overfishing impacts both targeted species and non-targeted species (or "bycatch" species) that are often important in marine food webs. Bycatch may also include seabirds, turtles, and marine mammals. In recent decades marine fisheries have targeted species lower on the food chain as the abundance of higher-level predators has decreased; some entire marine food webs have collapsed as a result (Pauly and Palomares 2005; Crain et al. 2009). Other factors, such as fisheries-induced evolution and intrinsic vulnerability to overfishing, have been shown to reduce the abundance of some populations (Kuparinen and Merila 2007). Fisheries-induced evolution is a change in genetic composition of the population, such as a reduction in the overall size of fish and individual growth rates resulting from intense fishing pressure. Intrinsic vulnerability describes certain life history traits (e.g., large body size, late maturity age, low growth rate), which increases the susceptibility of a species to overfishing (Cheung et al. 2007).

Pollution primarily impacts coastal fish near the sources of pollution. However, global oceanic circulation patterns result in a considerable amount of marine pollutants and debris scattered throughout the open ocean (Crain et al. 2009). Pollutants in the marine environment that may impact marine fish include organic contaminants (e.g., pesticides, herbicides, polycyclic aromatic hydrocarbons, flame retardants, and oil from run-off), inorganic chemicals (e.g., heavy metals), and debris (e.g., plastics and waste from dumping at sea) (Pew Oceans Commission 2003). High chemical pollutant levels in marine fish may cause behavioral changes, physiological changes, or genetic damage in some species (Pew Oceans Commission 2003; van der Oost et al. 2003; Goncalves et al. 2008; Moore 2008). Bioaccumulation of metals and organic pollutants is also a concern, particularly in terms of human health, because people consume top predators with potentially high pollutant loads. Bioaccumulation is the net buildup of substances (e.g., chemicals or metals) in an organism directly from contaminated water or sediment through the gills or skin, from ingesting food containing the substance (Newman 1998), or from ingestion of the substance itself (Moore 2008).

Entanglement in abandoned commercial and recreational fishing gear has also caused pollution-related declines for some marine fishes; some species are more susceptible to entanglement by marine debris than others (Musick et al. 2000).

Other human-caused stressors on marine fish are invasive species, climate change, aquaculture, energy production, vessel movement, and underwater noise:

- Non-native fish pose threats to native fish when they are introduced into an environment lacking natural predators and then compete with, and prey upon, native marine fish for resources (Whitfield et al. 2007; Crain et al. 2009), such as lionfish in the southeastern United States and the Caribbean.
- Global climate change is contributing to a shift in fish distribution from lower to higher latitudes (Glover and Smith 2003; Brander 2007; Limburg and Waldman 2009; Brander 2010; Dufour et al. 2010; Wilson et al. 2010).
- The threats of aquaculture operations on wild fish populations are reduced water quality, competition for food, predation by escaped or released farmed fish, spread of disease, and reduced genetic diversity (Ormerod 2003; Kappel 2005; Hansen and Windsor 2006). The National Oceanic and Atmospheric Administration is developing an aquaculture policy aimed at

promoting sustainable marine aquaculture (National Oceanic and Atmospheric Administration 2011).

- Energy production and offshore activities associated with power-generating facilities result in direct and indirect fish injury or mortality from two primary sources; including cooling water withdrawal that results in entrainment mortality of eggs and larvae and impingement mortality of juveniles and adults (U.S. Environmental Protection Agency 2004), and offshore wind energy development that results in acoustic impacts (Madsen et al. 2006).
- Vessel strikes pose threats to some large, slow-moving fish at the surface, although this is not considered a major threat to most marine fish (Kappel 2005). However, some species such as whale sharks, basking sharks, ocean sunfish, and manta rays have been struck by vessels (The Hawaii Association for Marine Education and Research Inc. 2005; Rowat et al. 2007; Stevens 2007; National Marine Fisheries Service 2010).
- Underwater noise is a threat to marine fish. However, the physiological and behavioral responses of marine fish to underwater noise (Popper 2003; Codarin et al. 2009; Slabbekoorn et al. 2010; Wright et al. 2010) have been investigated for only a limited number of fish species (Popper and Hastings 2009a, b). In addition to vessels, other sources of underwater noise include pile-driving activity (Feist et al. 1992; California Department of Transportation 2001; Nedwell et al. 2003; Popper et al. 2006; Carlson et al. 2007; Mueller-Blenkle et al. 2010) and seismic activity (Popper and Hastings 2009). Information on fish hearing is provided in Section 3.9.2.1 (Hearing and Vocalization), with further discussion in Section 3.9.3.1 (Acoustic Stressors).

3.9.2.3 Jawless Fishes (Orders Myxiniformes and Petromyzontiformes)

Hagfish (Myxiniformes) are the most primitive fish group (Nelson 2006). In fact, recent taxonomic revisions suggest that Myxiniformes are not fish at all but are a “sister” group to all vertebrates (Nelson 2006). However, jawless fish are generally thought of as fish and are therefore included in this section. Hagfish occur exclusively in marine habitats and are represented by 70 species worldwide in temperate marine locations. This group feeds on dead or dying fishes and have very limited external features often associated with fishes, such as fins and scales (Helfman et al. 2009). The members of this group are important scavengers that recycle nutrients back through the ecosystem.

No lampreys have been recorded in the Study Area, and only one species of hagfish has been recorded at depths greater than 650 ft. (200 m) (Myers and Donaldson 2003).

3.9.2.4 Sharks, Rays, and Chimaeras (Class Chondrichthyes)

The cartilaginous (non-bony) marine fishes of the class Chondrichthyes are distributed throughout the world’s oceans, occupying all areas of the water column (Paxton and Eschmeyer 1998). This group is mainly predatory and contains many of the apex predators found in the ocean (e.g., great white shark, mako shark, and tiger shark) (Helfman et al. 1997). The whale shark and basking shark are notable exceptions as filter-feeders. Sharks and rays have some unique features among marine fishes; no swim bladder; protective toothlike scales; unique sensory systems (electroreception, mechanoreception); and some species bear live young in a variety of life history strategies (Moyle and Cech 1996). The subclass Elasmobranchii contains more than 850 marine species, including sharks, rays and skates, spread across nine orders (Nelson 2006). Very little is known about the subclass Holocephali, which contains 58 marine species of chimaeras (Nelson 2006).

Sharks and rays occupy relatively shallow temperate and tropical waters throughout the world. More than half of these species occur in less than 655 ft. (199.6 m) of water, and nearly all are found at depths less than 6,560 ft. (1,999.5 m) (Nelson 2006). Sharks and rays are found in all open-ocean areas and coastal waters of the Study Area (Paxton and Eschmeyer 1998). While most sharks occur in the water column, many rays occur on or near the seafloor. In May 2007, a whale shark was sighted in the Study Area, halfway between Saipan and Farallon de Medinilla (Vogt 2008). A manta ray was observed off of Guam in March 2012 during a cetacean survey (HDR EOC 2012). Chimaeras are cool-water benthic marine fishes that are found on seafloors at depths between 260 and 8,500 ft. (79.2 and 2,590.8 m) (Nelson 2006). They may occur in the open-ocean portions of the Study Area (Paxton and Eschmeyer 1998).

3.9.2.5 Eels and Bonefishes (Orders Anguilliformes and Elopiformes)

These fishes have a unique larval stage, called leptocephalus, in which leptocephali grow to much larger sizes during an extended larval period as compared to most other fishes. The eels (Anguilliformes) have an elongated snakelike body; most of the 780 eel species do not inhabit the deep ocean. Eels generally feed on other fishes or small bottom-dwelling invertebrates, but will also take larger organisms (Helfman et al. 1997). Moray eels, snake eels, and conger eels are well represented by many species that occur in the Study Area (Paxton and Eschmeyer 1998). The order Elopiformes include two distinct groups with very different forms: the bonefishes, predators of shallow tropical waters; and the little-known spiny eels, elongated seafloor feeders which feed on decaying organic matter in deep ocean areas (Paxton and Eschmeyer 1998).

Eels are found in all marine habitat types, although most inhabit shallow subtropical or tropical marine habitats (Paxton and Eschmeyer 1998) in the Study Area. The bonefishes and spiny eels occur in deep ocean waters, ranging from 400 to 16,000 ft. (121.9 to 4,876.8 m) within the open-ocean area of the Study Area, throughout the Pacific on the seafloor and in the water column, and bonefish are also found in near-shore habitats (Paxton and Eschmeyer 1998).

3.9.2.6 Sardines and Anchovies (Order Clupeiformes)

Many of the 364 species of the order Clupeiformes are found primarily in the Indo-west Pacific or the western Atlantic. These sardine and anchovy species are one of the most well-defined orders of fishes because of their importance to commercial fisheries (Nelson 2006). This group of fishes swims together (school) to help conserve energy and minimize predation (Brehmer et al. 2007). Herrings account for a large portion of the total worldwide fish catch (United Nations Environment Programme 2005; United Nations Environment Programme 2009). Sardine and anchovies are also an important part of marine food webs because they are the targeted prey for many marine species, including other fishes, birds, and mammals. The clupeids feed on decaying organic matter and plankton (Moyle and Cech 1996).

Clupeiformes are often concentrated in large schools near the surface. They are common in the coastal waters of the Study Area (Paxton and Eschmeyer 1998; Myers and Donaldson 2003).

3.9.2.7 Hatchetfish and Lanternfishes (Orders Stomiiformes and Myctophiformes)

The orders Stomiiformes and Myctophiformes comprise one of the largest groups of the world's deepwater fishes—more than 500 total species, many of which are not very well described in the scientific literature (Nelson 2006). The ecological role of many of these species is also not well understood (Helfman et al. 2009) These fishes are known for their unique body forms (e.g., slender bodies, or disc-like bodies, often possessing light-producing capabilities) and adaptations that likely present some advantages within the deepwater habitats in which they occur (e.g., large mouths, sharp teeth, and sensitive lateral line [sensory] systems) (Haedrich 1996; Koslow 1996; Marshall 1996; Rex and Etter 1998; Warrant and Locket 2004).

Overall the hatchetfish and lanternfishes occur in deep ocean waters, ranging from 3,280 to 16,000 ft. (999.7 to 4,876.8 m), making diurnal migrations within the open ocean area of the Study Area (Froese and Pauly 2010; Paxton and Eschmeyer 1998).

3.9.2.8 Greeneyes, Lizardfishes, Lancetfishes, and Telescopefishes (Order Aulopiformes)

Fishes of the order Aulopiformes are a diverse group that possess both primitive (adipose [fatty] fin, rounded scales) and advanced (unique swim bladder and jawbone) features of marine fishes (Paxton and Eschmeyer 1998). They are common in estuarine and coastal waters to the deep ocean. The lizardfish (Synodontidae), Bombay ducks (Harpadontidae) primarily occur in coastal waters to the outer shelf, where they rest on the bottom and are well camouflaged with the substrate (Paxton and Eschmeyer 1998). Lancetfish (Alepisauridae) are primarily mid-water column fish, but are known from the surface to deep water. Telescopefish are primarily found in deep waters from 1,640 to 3,280 ft. (499.9 to 999.7 m), but they can also be found at shallower depths and may approach the surface at night (Paxton and Eschmeyer 1998).

In general greeneyes, lizardfishes, and lancetfishes occur in the coastal waters of the Study Area. Telescopefishes and bathysaurids occur primarily in the deeper waters associated with the open-ocean areas of the Study Area (Paxton and Eschmeyer 1998).

3.9.2.9 Cods and Cusk-eels (Orders Gadiformes and Ophidiiformes)

The order Ophidiiformes includes cusk-eels and brotulas, which have long eel-like tapering bodies and are distributed in deepwater areas throughout tropical and temperate oceans (Paxton and Eschmeyer 1998). The characteristics of ophidiiforms are similar to those of the other deepwater groups. Other fishes of this order are also found in shallow waters on coral reefs. In addition, there are several cusk-eel species which are pelagic or found on the continental shelves and slopes.

Cods are generally found near the seafloor and feed on bottom-dwelling organisms. They do not occur in the Study Area (Paxton and Eschmeyer 1998). Cusk-eels occur near the seafloor of the coastal waters and in the open-ocean areas of the Study Area (Paxton and Eschmeyer 1998).

3.9.2.10 Toadfishes and Anglerfishes (Orders Batrachoidiformes and Lophiiformes)

The order Batrachoidiformes includes only the toadfish family. Some species of toadfishes produce and detect sounds by vibrating the swimbladder. They spawn in and around bottom structures and invest a substantial amount of parental care by defending their nests (Moyle and Cech 1996, Paxton and Eschmeyer 1998). The order Lophiiformes includes all of the world’s anglerfishes, goosefishes, frogfishes, batfishes, and deepwater anglerfishes, most of which occur in seafloor habitats of all oceans. Some deepwater anglerfish use highly modified “lures” to attract prey (Koslow 1996; Helfman et al. 2009). The males of these species are small and parasitic, spending their life attached to the side of the female (Helfman et al. 2009). The anglerfishes can be broken into two groups: (1) those that dwell in the deep water (10 families), and (2) those that live on the bottom or attached to drifting seaweed in shallow water (5 families). Toadfish are not found within the Study Area; however, anglerfish are found in the Study Area at depths ranging from 65.5 to 328 ft. (20 to 100 m) (Paxton and Eschmeyer 1998).

3.9.2.11 Mullets, Silversides, Needlefish, and Killifish (Orders Mugiliformes, Atheriniformes, Beloniformes, and Cyprinodontiformes)

Mugiliformes (mullets) contain 71 marine species that occupy coastal marine and estuarine waters of all tropical and temperate oceans. There has been disagreement in the taxonomic classification of this group; some have included this group within the super order Athinerimorpha (Nelson 2006), while others have placed it as a suborder within the Perciformes (Moyle and Cech 1996). Mullets feed on decaying organic matter in estuaries and possess a filter-feeding mechanism with a gizzard-like digestive tract. They feed on the bottom by scooping up food and retaining it in their very small gill rakers (Moyle and Cech 1996). Most species within these groups are important prey for predators in all estuarine habitats within the Study Area.

Most of these fishes are found in tropical or temperate marine waters and occupy shallow habitats near the water surface. An exception to this nearshore distribution includes the flyingfishes and halfbeaks, which occur in the oceanic or shallow seacoast regions where light penetrates, in tropical to warm-temperate regions. The silversides are a small inshore species often found in intertidal habitats. The Cyprinodontiformes include the killifishes that are often associated with intertidal coastal zones and salt marsh habitats and are highly tolerant of pollution. These fishes are found in all coastal waters and open ocean areas of the Study Area (Froese and Pauly 2010; Paxton and Eschmeyer 1998).

3.9.2.12 Oarfishes, Squirrelfishes, and Dories (Orders Lampridiformes, Beryciformes, and Zeiformes)

There are only 19 species in the order Lampridiformes—the oarfishes (Nelson 2006). They exhibit diverse body shapes, and some have a protruding mouth, which allows for a suction feeding technique while feeding on plankton. Other species, including the crestfish, posses grasping teeth used to catch prey. They occur only in the mid-water column of the open ocean, but are rarely observed (Nelson 2006). Fishes in the order Beryciformes are primarily either deepwater or nocturnal species, many of which are poorly described. There are a few shallow water exceptions, including squirrelfishes, which are distributed throughout reef systems in tropical and subtropical marine regions (Nelson 2006). Squirrelfishes are relied upon by some communities who catch their own food (Froese and Pauly 2010). They possess specialized eyes and large mouths and primarily feed on bottom-dwelling crustaceans (Goatley and Bellwood 2009). Very little is known about the order Zeiformes, or dories, which includes some very rare families, many containing only a single species (Paxton and Eschmeyer 1998). Even general information on their biology, ecology, and behavior is limited.

Squirrelfishes are common in coral reef systems in the Study Area. Most of the Lampridiformes and Zeiformes are confined to seafloor regions in all coastal waters of the Study Area, as well as the open-ocean areas at depths of 130 to 330 ft. (39.6 to 100.6 m) (Paxton and Eschmeyer 1994; Moyle and Cech 1996).

3.9.2.13 Pipefishes and Seahorses (Order Gasterosteiformes)

Gasterosteiformes include sticklebacks, pipefishes, and seahorses. Most of these species are found in brackish water (a mixture of seawater and freshwater) throughout the world (Nelson 2006) and occur in surface, water column, and seafloor habitats. Small mouths on a long snout and armorlike scales are characteristic of this group. Most of these species exhibit a high level of parental care, either through nest building (sticklebacks) or brooding pouches (seahorses have a pouch where eggs develop), which results in relatively few young being produced (Helfman et al. 1997). This group also includes the trumpetfishes and cornetfishes, ambush predators, with a large mouth used to capture smaller lifestages of fishes.

This group is associated with tropical and temperate reef systems. They are found in the coastal waters of the Study Area (Paxton and Eschmeyer 1998).

3.9.2.14 Scorpionfishes (Order Scorpaeniformes)

The order Scorpaeniformes is a diverse group of more than 1,400 marine species, all with bony plates or spines near the head. This group contains the scorpionfishes, waspfishes, rockfishes, velvetfishes, pigfishes, sea robins, gurnards, sculpins, snailfishes, and lumpfishes (Paxton and Eschmeyer 1998). Many of these fishes are adapted for inhabiting the seafloor of the marine environment (e.g., modified pectoral fins or suction discs), where they feed on smaller crustaceans and fishes. Sea robins are capable of generating sounds with their swimbladders and are among the noisiest of all fish species within the Study Area (Moyle and Cech 1996).

Scorpionfishes are widely distributed in open-ocean and coastal habitats, at all depths, throughout the world. They occur in all waters of the Study Area. Most occur in depths less than 330 ft. (100.6 m), but others are found in deepwater habitat, down to 7,000 ft. (2,133.6 m) (Paxton and Eschmeyer 1998).

3.9.2.15 Snappers, Drums, and Croakers (Families Sciaenidae and Lutjanidae)

The families Sciaenidae and Lutjanidae include mainly predatory coastal marine fishes, including the recreationally important snappers, drums, and croakers. These fishes are sometimes distributed in schools as juveniles then become more solitary as they grow larger. They feed on fishes and crustaceans. Drums and croakers (Sciaenidae) produce sounds via their swimbladders, which generate a drumming sound. The snappers (Lutjanidae) are generally associated with seafloor habitats and tend to congregate near structured habitats, including natural/artificial reefs and oil platforms (Moyle and Cech 1996). Other representative groups include the brightly colored and diverse forms of reef-associated cardinalfishes, butterflyfishes, angelfishes, dottybacks, and goatfishes (Paxton and Eschmeyer 1998).

Like the scorpionfishes, the drums, snappers, snooks, and temperate basses are widely distributed in open-ocean and coastal habitats throughout the world. They occur in all waters of the Study Area, but are particularly concentrated, and exhibit the most varieties, in depths less than 330 ft. (100.6 m), often associated with reef systems (Paxton and Eschmeyer 1994; Froese and Pauly 2010).

3.9.2.16 Groupers and Sea Basses (Family Serranidae)

The Serranidae are primarily nearshore marine fishes that support recreational and commercial fisheries. Seabasses and groupers are nocturnal predators found primarily within reef systems. They generally possess specialized eyes and large mouths and feed mostly on bottom-dwelling fishes and crustaceans (Goatley and Bellwood 2009). Some groupers and seabasses take advantage of feeding opportunities in the low-light conditions of twilight when countershaded fishes become conspicuous and easier for these predators to locate (Rickel and Genin 2005). Other groupers are active during the daytime and exhibit a variety of opportunistic predatory strategies, such as ambush (Wainwright and Richard 1995) to benefit from mistakes made by prey species. Many of the serranids begin life as females and then become male as they grow larger (Moyle and Cech 1996). This group occurs in all coastal waters of the Study Area, but are mostly concentrated in depths less than 100 ft. (30.5 m) within the Study Area (Moyle and Cech 1996; Paxton and Eschmeyer 1998; Froese and Pauly 2010).

3.9.2.17 Wrasses, Parrotfish, and Damselfishes (Families Labridae, Scaridae, and Pomacentridae)

The suborder Labroidei contains many nearshore marine reef or structure-associated fishes, including the diverse wrasses (Labridae), parrotfishes (Scaridae), and damselfishes (Pomacentridae). Most of the wrasses are conspicuous, brightly colored, coral reef fishes, but others are found in temperate waters. Most are active during the daytime and exhibit a variety of opportunistic predatory strategies, such as ambush (Wainwright and Richard 1995) to capitalize on mistakes made by prey species. Parrotfishes provide important ecological functions to the reef system by grazing on coral and processing sediments (Goatley and Bellwood 2009). Similar to the Serranidae, many wrasses and parrotfishes begin life as females but change into males as they grow larger and exhibit with a variety of reproductive strategies found among the species and between populations (Moyle and Cech 1996). Damselfishes are noted for their territoriality and are brightly colored. This group occurs in all coastal waters of the Study Area, but are mostly concentrated in depths less than 100 ft. (30.5 m) within the Study Area (Moyle and Cech 1996; Paxton and Eschmeyer 1998; Froese and Pauly 2010). This group includes the ESA candidate species, the humphead wrasse, see Section 3.9.1.1 (Endangered Species Act Species).

3.9.2.18 Gobies, Blennies, and Surgeonfishes (Suborders Gobiodei, Blennioidei, and Acanthuroidei)

The seafloor-dwelling gobies (suborder Gobiodei) include Gobiidae, the largest family of marine fishes (Nelson 2006); they exhibit modified pelvic fins that allow them to adhere to various bottom surfaces (Helfman et al. 2009). Fishes of the suborder Blennioidei primarily occupy the intertidal zones throughout the world, including the clinid blennies and the combtooth blennies of the family Blenniidae (Moyle and Cech 1996; Mahon et al. 1998; Nelson 2006). The blennies and gobies primarily feed on seafloor debris. The suborder Acanthuroidei contains the surgeonfishes, moorish idols, and rabbitfishes of tropical reef systems. They have elongated small mouths used to scrape algae from coral. These grazers provide an important function to the reef system by controlling the growth of algae on the reef (Goatley and Bellwood 2009). Some of these species are adapted to target particular prey species; for example, the elongated snouts of butterflyfishes allow them to bite off exposed parts of invertebrates (Leysen et al. 2010).

These fishes occur in all coastal waters of the Study Area, but are mostly concentrated, and exhibit the most varieties, in depths less than 100 ft. (30.5 m) within the Study Area (Moyle and Cech 1996; Paxton and Eschmeyer 1998; Froese and Pauly 2010).

3.9.2.19 Jacks, Tunas, Mackerels, and Billfishes (Families Carangidae, Xiphiidae, and Istiophoridae and Suborder Scombroidei)

The suborder Scombroidei contains some of the most voracious open-ocean predators: the jacks, mackerels, barracudas, billfishes, and tunas (Estrada et al. 2003; Sibert et al. 2006). Many jacks are known to feed nocturnally (Goatley and Bellwood 2009) and in the low light of twilight (Rickel and Genin 2005) by ambushing their prey (Sancho 2000). The open-ocean, highly migratory tunas, mackerels, and billfishes are extremely important to fisheries; they constitute a large component of the total annual worldwide catch by weight, with tunas and swordfish as the most important species (United Nations Environment Programme 2005; United Nations Environment Programme 2009). One unique adaptation found in these fishes is ram ventilation (Wegner et al. 2006). Ram ventilation uses the motion of the fish through the water to increase respiratory efficiency in large, fast-swimming open-ocean fishes (Wegner et al. 2006). Many fishes in this group have large-scale migrations that allow for feeding in highly productive areas, which vary by season (Pitcher 1995).

These fishes occupy the open-ocean areas that comprise the largest area of ocean but make up only about 5 percent of the total marine fishes (Helfman et al. 1997; Froese and Pauly 2010). They are mostly found near the surface, or the upper portion of the water column, located within all coastal waters and open-ocean areas of the Study Area (Paxton and Eschmeyer 1998; Froese and Pauly 2010).

3.9.2.20 Flounders (Order Pleuronectiformes)

The order Pleuronectiformes includes flatfishes (flounders, dabs, soles, and tonguefishes) that are found in all marine seafloor habitats throughout the world (Nelson 2006). Fishes in this group have eyes on either the left side or the right side of the head and are not symmetrical like other fishes (Saele et al. 2004). All flounder species are ambush predators, feeding mostly on other fishes and bottom-dwelling invertebrates (Drazen and Seibel 2007; Froese and Pauly 2010).

This group is widely distributed on the seafloor of open-ocean and coastal habitats throughout the world. They occur in all waters of the Study Area, but are particularly concentrated, and exhibit the most varieties, in depths less than 330 ft. (100.6 m), often associated with sand bottoms within the Study Area (Paxton and Eschmeyer 1998; Froese and Pauly 2010).

3.9.2.21 Triggerfish, Puffers, and Molas (Order Tetraodontiformes)

The fishes in the order Tetraodontiformes are the most advanced group of modern bony fishes. This order includes the triggerfishes, filefishes, puffers, and ocean sunfishes (Nelson 2006). Like the flounders, this group exhibits body shapes unique among marine fishes, including modified spines or other structures advantageous in predator avoidance. The unique body shapes also require the use of a tail swimming style because some species lack the muscle structure and body shape of other fishes. Most of these fishes are active during the daytime and exhibit a variety of strategies for catching prey, such as ambushing their prey (Wainwright and Richard 1995). The ocean sunfishes (*Mola* species) are the largest bony fish and the most prolific vertebrate species, with females producing more than 300 million eggs in a breeding season (Moyle and Cech 1996). The ocean sunfishes occur very close to the surface. They are slow swimming and feed on a variety of plankton (including jellyfish), crustaceans, and fishes (Froese and Pauly 2010). Their only natural predators are sharks, orcas, and sea lions (Helfman et al. 1997).

Most species within this group are associated with reef systems. This group is widely distributed in tropical and temperate bottom or mid-water column habitats (open-ocean and coastal) throughout the world. They occur in all waters of the Study Area, but are particularly concentrated, and exhibit the most varieties, in depths less than 330 ft. (100.6 m), often associated with reefs or structured seafloor habitats (Paxton and Eschmeyer 1998; Froese and Pauly 2010). One major exception is for the molas (ocean sunfishes), which occur at the surface in all open-ocean areas (Helfman et al. 1997).

3.9.3 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 fishes known to occur within the Study Area. Chapter 2 presents the baseline and proposed training and testing activity locations for each alternative (including number of activities and ordnance expended). The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to marine fish in the Study Area and analyzed below include the following:

- Acoustic (sonar and other active acoustic sources; underwater explosives; swimmer defense airguns; weapons firing, launch, and impact noise; vessel noise; and aircraft noise)
- Energy (electromagnetic devices)
- Physical disturbance and strike (vessels, in-water devices, military expended materials, seafloor devices)
- Entanglement (fiber optic cables and guidance wires, decelerators/parachutes)

- Ingestion (munitions and military expended materials other than munitions)
- Secondary

Each of these components was carefully analyzed for potential impacts on fishes 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 fish 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 included in Chapter 2 (Description of Proposed Action and Alternatives).

3.9.3.1 Acoustic Stressors

The following sections analyze potential impacts on fish from proposed activities that involve acoustic stressors (non-impulse and impulse).

3.9.3.1.1 Analysis Background and Framework

This section is largely based on a technical report prepared for the Navy: *Effects of Mid- and High-Frequency Sonars on Fish* (Popper 2008). Additionally, Popper and Hastings (2009) provide a critical overview of some of the most recent research regarding potential effects of anthropogenic sound on fish.

Studies of the effects of human-generated sound on fish have been reviewed in numerous places (e.g., National Research Council 1994; National Research Council 2003; Popper 2003; Popper et al. 2004; Hastings and Popper 2005; Popper 2008; Popper and Hastings 2009). Most investigations, however, have been in the gray literature (non peer-reviewed reports). See Hastings and Popper (2005), Popper (2008), and Popper and Hastings (2009) for extensive critical reviews of this material.

Fish have been exposed to short-duration, high-intensity signals such as those that might be found near high-frequency sonar, pile driving, or a seismic airgun survey. Such studies examined short-term effects that could result in death to the exposed fish, as well as hearing loss and long-term consequences. Recent experimental studies have provided additional insight into the issues (e.g., Govoni et al. 2003; McCauley et al. 2003; Popper et al. 2005; Popper et al. 2007; Doksaeter et al. 2009; Kane et al. 2010).

3.9.3.1.1.1 Direct Injury

<u>Non-Impulsive Acoustic Sources</u>

Potential direct injuries from non-impulse sound sources, such as sonar, are unlikely because of the relatively lower peak pressures and slower rise times than potentially injurious sources such as explosives. Non-impulse sources also lack the strong shock wave such as that associated with an explosion. Therefore, direct injury is not likely to occur from exposure to non-impulse sources such as sonar, vessel noise, or subsonic aircraft noise. The theories of sonar-induced acoustic resonance, neurotrauma, and lateral line system injury are discussed below, although these phenomena are difficult to recreate under real-world conditions and are therefore unlikely to occur.

Two unpublished reports examined the effects of mid-frequency sonar-like signals (1.5 to 6.5 kHz) on larval and juvenile fish of several species (Jørgensen et al. 2005; Kvadsheim and Sevaldsen 2005). In the first study, Kvadsheim and Sevaldsen (2005) showed that intense sonar activities in herring spawning areas affected less than 0.3 percent of the total juvenile stock. The second study, Jørgensen et al. (2005) exposed larval and juvenile fish to various sounds to investigate potential effects on survival, development, and behavior. The study used herring (*Clupea harengus*) (standard length 2 to 5 centimeters [cm] [0.8 to 2 inches {in.}]), Atlantic cod (*Gadus morhua*) (standard length 2 and 6 cm [0.8 and 2.3 in.]), saithe (*Pollachius virens*) (4 cm [1.6 in.]), and spotted wolffish (*Anarhichas minor*) (4 cm [1.6 in.]) at different developmental stages. The researchers placed the fish in plastic bags 10 ft. (3 m) from the sound source and exposed them to between 4 and 100 pulses of 1 second duration of pure tones at 1.5, 4, and 6.5 kHz. The fish in only two groups out of the 82 tested exhibited any adverse effects. These two groups were both composed of herring and were tested with sound pressure levels of 189 dB re 1 µPa, which resulted in a post-exposure mortality of 20 to 30 percent. In the remaining 80 groups tested, 42 of which were replicates of herring only, there were no observed effects on growth (length and weight) or the survival of fish that were kept as long as 34 days post exposure. While statistically significant losses were documented in the two groups impacted, the researchers only tested that particular sound level once, so it is not known if this increased mortality was due to the level of the test signal or to other unknown factors.

High sound pressure levels may cause bubbles to form from micronuclei in the blood stream or other tissues of animals, possibly causing embolism damage (Ketten 1998). Fish have small capillaries where these bubbles could be caught and lead to the rupturing of the capillaries and internal bleeding. It has also been speculated that this phenomena could also take place in the eyes of fish due to potentially high gas saturation within the fish's eye tissues (Popper and Hastings 2009).

As reviewed in Popper and Hastings (2009), Hastings (1990, 1995) found 'acoustic stunning' (loss of consciousness) in blue gouramis (*Trichogaster trichopterus*) following an 8-minute exposure to a 150 Hz pure tone with a peak sound pressure level of 198 dB re 1 µPa. This species of fish has an air bubble in the mouth cavity directly adjacent to the animal's braincase that may have caused this injury. Hastings (1990, 1995) also found that goldfish exposed to 2 hours of continuous wave sound at 250 Hz with peak pressures of 204 dB re 1 µPa, and fathead minnows exposed to 0.5 hour of 150 Hz continuous wave sound at a peak level of 198 dB re 1 µPa, did not survive.

The only study on the effect of exposure of the lateral line system to continuous wave sound (conducted on one freshwater species, the Oscar [*Astronatus ocellatus*]) suggests no effect on these sensory cells by intense pure tone signals (Hastings et al. 1996).

Explosives and Other Acoustic Sources

The greatest potential for direct, non-auditory tissue effects is primary blast injury and barotrauma following exposure to high amplitude impulse 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., swim bladder and gut) and the auditory system. Barotrauma refers to injuries caused when large pressure changes occur across tissue interfaces, normally at the boundaries of gas-filled tissues such as the swim bladder of fish.

An underwater explosion generates a shock wave that produces a sudden, intense change in local pressure as it passes through the water (U.S. Department of the Navy 1998, 2001). Pressure waves extend to a greater distance than other forms of energy produced by the explosion (i.e., heat and light) and are therefore the most likely source of negative effects to marine life from underwater explosions (Craig 2001; Scripps Institution of Oceanography 2005; U.S. Department of the Navy 2006).

The shock wave from an underwater explosion is lethal to fish at close range, causing massive organ and tissue damage and internal bleeding (Keevin and Hempen 1997). At greater distance from the detonation point, the extent of mortality or injury depends on a number of factors including fish size, body shape, orientation, and species (Wright 1982; Keevin and Hempen 1997). At the same distance from the source, larger fish are generally less susceptible to death or injury, elongated forms that are round in cross-section are less at risk than deep-bodied forms, and fish oriented sideways to the blast suffer the greatest impact (Yelverton et al. 1975; Wiley et al. 1981; O'Keefe and Young 1984; Edds-Walton and Finneran 2006). Species with gas-filled organs have higher mortality than those without them (Goertner et al. 1994), which includes most fish found in the Study Area.

Two aspects of the shock wave appear most responsible for injury and death to fish: the received peak pressure and the time required for the pressure to rise and decay (Dzwilewski and Fenton 2002). Higher peak pressure and abrupt rise and decay times are more likely to cause acute pathological effects (Wright and Hopky 1998). Rapidly oscillating pressure waves might rupture the kidney, liver, spleen, and sinus and cause venous hemorrhaging (Keevin and Hempen 1997). They can also generate bubbles in blood and other tissues, possibly causing embolism damage (Ketten 1998). Oscillating pressure waves might also burst gas-containing organs. The swim bladder, the gas-filled organ used by many pelagic fish and coastal fish to control buoyancy, is the primary site of damage from explosives (Yelverton et al. 1975; Wright 1982). Gas-filled swim bladders resonate at different frequencies than surrounding tissue and can be torn by rapid oscillation between high- and low-pressure waves. Swim bladders are a characteristic of bony fishes and are not present in sharks and rays.

Studies that have documented fish killed during planned underwater explosions indicate that most fish that die do so within 1 to 4 hours, and almost all die within a day (Hubbs and Rechnizer 1952; Yelverton et al. 1975). Fitch and Young (1948) found that the type of fish killed changed when blasting was repeated at the same marine location within 24 hours of previous blasting. They observed that most fish killed on the second day were scavengers, presumably attracted by the victims of the previous day's blasts. However, fishes collected during these types of studies have mostly been recovered floating on the water's surface. Gitschlag et al. (2000) collected both floating fish and those that were sinking or lying on the bottom after explosive removal of nine oil platforms in the northern Gulf of Mexico. They found that 3 to 87 percent (46 percent average) of the specimens killed during a blast might float to the surface. Other impediments to accurately characterizing the magnitude of fish mortality included currents and winds that transported floating fishes out of the sampling area and predation by seabirds or other fishes.

There have been few studies of the impact of underwater explosions on early life stages of fish (eggs, larvae, juveniles). Fitch and Young (1948) reported the demise of larval anchovies exposed to underwater blasts off California, and Nix and Chapman (1985) found that anchovy and smelt larvae died following the detonation of buried charges. Similar to adult fish, the presence of a swim bladder contributes to shock wave-induced internal damage in larval and juvenile fish (Settle et al. 2002). Shock wave trauma to internal organs of larval pinfish and spot from shock waves was documented by Govoni et al. (2003). These were laboratory studies, however, and have not been verified in the field.

It has been suggested that impulse sounds, such as those produced by seismic airguns, may cause damage to the cells of the lateral line in fish larvae and juveniles when in proximity (5 m [16 ft.]) to the sound source (Booman et al. 1996).

3.9.3.1.1.2 Hearing Loss

Exposure to high intensity sound can cause hearing loss, also known as a noise-induced threshold shift, or simply a threshold shift (Miller 1974). A Temporary Threshold Shift (TTS) is a temporary, recoverable loss of hearing sensitivity. A TTS may last several minutes to several weeks and the duration may be related to the intensity of the sound source and the duration of the sound (including multiple exposures). A Permanent Threshold Shift (PTS) is non-recoverable, results from the destruction of tissues within the auditory system, and can occur over a small range of frequencies related to the sound exposure. As with TTS, the animal does not become deaf but requires a louder sound stimulus (relative to the amount of PTS) to detect a sound within the affected frequencies; however, in this case, the effect is permanent.

Permanent hearing loss has not been documented in fish. The sensory hair cells of the inner ear in fish can regenerate after they are damaged, unlike in mammals where sensory hair cells loss is permanent (Lombarte et al. 1993; Smith et al. 2006). As a consequence, any hearing loss in fish may be as temporary as the timeframe required to repair or replace the sensory cells that were damaged or destroyed (e.g., Smith et al. 2006).

Non-Impulsive Acoustic Sources

Studies of the effects of long-duration sounds with sound pressure levels below 170 to 180 dB re 1 µPa indicate that there is little to no effect of long-term exposure on species that lack notable anatomical hearing specialization (Scholik and Yan 2001; Amoser and Ladich 2003; Smith et al. 2004a, b; Wysocki et al. 2007). The longest of these studies exposed young rainbow trout (*Onorhynchus mykiss*), to a level of noise equivalent to one that fish would experience in an aquaculture facility (e.g., on the order of 150 dB re 1 µPa) for about nine months. The investigators found no effect on hearing (i.e., TTS) as compared to fish raised at 110 dB re 1 µPa.

In contrast, studies on fish with hearing specializations (i.e., greater sensitivity to lower sound pressures and higher frequencies) have shown that there is some hearing loss after several days or weeks of exposure to increased background sounds, although the hearing loss seems to recover (e.g., Scholik and Yan 2002; Smith et al. 2004a; Smith et al. 2006). Smith et al. (2004, 2006) exposed goldfish to noise at 170 dB re 1 µPa and found a clear relationship between the amount of hearing loss (TTS) and the duration of exposure until maximum hearing loss occurred after 24 hours of exposure. A 10-minute exposure resulted in a 5 dB TTS, whereas a 3-week exposure resulted in a 28 dB TTS that took over 2 weeks to return to pre-exposure baseline levels (Smith et al. 2004a) (note: recovery time was not measured by investigators for shorter exposure durations).

Similarly, Wysocki and Ladich (2005) investigated the influence of noise exposure on the auditory sensitivity of two freshwater fish with notable hearing specializations, the goldfish and the lined Raphael catfish (*Platydoras costatus*), and on a freshwater fish without notable specializations, the pumpkinseed sunfish (*Lepomis gibbosus*). Baseline thresholds showed greatest hearing sensitivity around 500 Hz in the goldfish and catfish and at 100 Hz in the sunfish. For the goldfish and catfish, continuous white noise of approximately 130 dB re 1 µPa at 1 m resulted in a significant TTS of 23 to 44 dB. In contrast, the auditory thresholds in the sunfish declined by 7 to 11 dB. The duration of exposure and time to recovery was not addressed in this study. Scholik and Yan (2001) demonstrated TTS in fathead minnows (*Pimephales promelas*). After a 24-hour exposure to white noise (300–2,000 Hz) at 142 dB re 1 µPa, recovery took as long as 14 days post-exposure.

Studies have also examined the effects of the sound exposures from Surveillance Towed Array Sensor System Low-Frequency Active sonar on fish hearing (Popper et al. 2007; Kane et al. 2010). Hearing was measured both immediately post exposure and for several days thereafter. Maximum received sound pressure levels were 193 dB re 1 µPa for 324 or 628 seconds. Catfish and some specimens of rainbow trout showed 10 to 20 dB of hearing loss immediately after exposure to the low-frequency active sonar when compared to baseline and control animals; however, another group of rainbow trout showed no hearing loss. Recovery in trout took at least 48 hours, but studies were not completed. The different results between rainbow trout groups is difficult to understand, but may be due to developmental or genetic differences in the various groups of fish. Catfish hearing returned to, or close to, normal within about 24 hours after exposure to low-frequency active sonar. Furthermore, examination of the inner ears of the fish during necropsy (note: maximum time fish were held post exposure before sacrifice was 96 hours) revealed no differences from the control groups in cilliary bundles or other features indicative of hearing loss (Kane et al. 2010).

The study of mid-frequency active sonar by the same investigators also examined potential effects on fish hearing and the inner ear (Kane et al. 2010; Halvorsen et al. 2012). Out of the four species tested (rainbow trout, channel catfish, largemouth bass, and yellow perch) only one group of channel catfish, tested in December, showed any hearing loss after exposure to mid-frequency active sonar. The signal consisted of a 2-second-long, 2.8–3.8 kHz frequency sweep followed by a 3,300 Hz tone of 1 second duration. The stimulus was repeated five times with a 25-second interval. The maximum received sound pressure level was 210 dB re 1 µPa. These animals, which have the widest hearing range of any of the species tested, experienced approximately 10 dB of threshold shift that recovered within 24 hours. Channel catfish tested in October did not show any hearing loss. The investigators speculated that the difference in hearing loss between catfish groups might have been due to the difference in water temperature of the lake where all of the testing took place (Seneca Lake, New York) between October and December. Alternatively, the observed hearing loss differences between the two catfish groups might have been due to differences between the two stocks of fish (Halvorsen et al. 2012). Any effects on hearing in channel catfish due to sound exposure appear to be transient (Kane et al. 2010; Halvorsen et al. 2012). Investigators observed no damage to cilliary bundles or other features indicative of hearing loss in any of the other fish tested including the catfish tested in October (Kane et al. 2010).

Some studies have suggested that there may be some loss of sensory hair cells due to high intensity sources; however, none of these studies concurrently investigated effects on hearing. Enger (1981) found loss of cilliary bundles of the sensory cells in the inner ears of Atlantic cod (*Gadus morhua*) following 1 to 5 hours of exposure to pure tone sounds between 50 and 400 Hz with a sound pressure level of 180 dB re 1 µPa. Hastings (1995) found auditory hair-cell damage in a species with notable anatomical hearing specializations, the goldfish (*Carassius auratus*) exposed to 250 Hz and 500 Hz continuous tones with maximum peak levels of 204 dB re 1 µPa and 197 dB re 1 µPa, respectively, for about two hours. Similarly, Hastings et al. (1996) demonstrated damage to some sensory hair cells in oscars (*Astronotus ocellatus*) following a one hour exposure to a pure tone at 300 Hz with a peak pressure level of 180 dB re 1 µPa. In none of the studies was the hair cell loss more than a relatively small percent (less than a maximum of 15 percent) of the total sensory hair cells in the hearing organs.

Explosives and Other Impulsive Acoustic Sources

Popper et al. (2005) examined the effects of a seismic airgun array on a fish with hearing specializations, the lake chub (*Couesius plumbeus*), and two species that lack notable specializations, the northern pike (*Esox lucius*) and the broad whitefish (*Coregonus nasus*) (a salmonid). In this study the average received exposure levels were a mean peak pressure level of 207 dB re 1 µPa; sound pressure level of 197 dB re 1 µPa; and single-shot sound exposure level of 177 decibels referenced to 1 micropascal squared second (dB re 1 μPa^2-s). The results showed temporary hearing loss for both lake chub and northern pike to both 5 and 20 airgun shots, but not for the broad whitefish. Hearing loss was approximately 20 to 25 dB at some frequencies for both the northern pike and lake chub, and full recovery of hearing took place within 18 hours after sound exposure. Examination of the sensory surfaces of the ears by an expert on fish inner ear structure showed no damage to sensory hair cells in any of the fish from these exposures (Song et al. 2008).

McCauley et al. (2003) showed loss of a small percent of sensory hair cells in the inner ear of the pink snapper (*Pagrus auratus*) exposed to a moving airgun array for 1.5 hours. Maximum received levels exceeded 180 dB re 1 µPa^2-s for a few shots. The loss of sensory hair cells continued to increase for up to at least 58 days post exposure to 2.7 percent of the total cells, with disproportionate damage (approximately 15 percent of hair cells) in the caudal portion of the ear. It is not known if this hair cell loss would result in hearing loss since fish have tens or even hundreds of thousands of sensory hair cells in the inner ear (Popper and Hoxter 1984; Lombarte and Popper 1994) and only a small portion were affected by the sound. The question remains as to why McCauley et al. (2003) found damage to sensory hair cells while Popper et al. (2005) did not. There are many differences between the studies, including species, precise sound source, and spectrum of the sound that it is hard to speculate.

Hastings et al. (2008) exposed the pinecone soldierfish (*Myripristis murdjan*), a fish with anatomical specializations to enhance their hearing; and three species without notable specializations: the blue green damselfish (*Chromis viridis*), the saber squirrelfish (*Sargocentron spiniferum*), and the bluestripe seaperch (*Lutjanus kasmira*) to an airgun array. Fish in cages in 5 m (16 ft.) of water were exposed to multiple airgun shots with a cumulative sound exposure level of 190 dB re 1 µPa^2-s. The authors found no hearing loss in any fish following exposures.

3.9.3.1.1.3 Auditory Masking

Auditory masking refers to the presence of a noise that interferes with a fish's ability to hear biologically relevant sounds. Fish use sounds to detect predators and prey, and for schooling, mating, and navigating, among other uses (Myrberg 1980; Popper et al. 2003). Masking of sounds associated with these behaviors could have impacts to fish by reducing their ability to perform these biological functions.

Any noise (i.e., unwanted or irrelevant sound, often of an anthropogenic nature) detectable by a fish can prevent the fish from hearing biologically important sounds including those produced by prey or predators (Myrberg 1980; Popper et al. 2003). Auditory masking may take place whenever the noise level heard by a fish exceeds ambient noise levels, the animal's hearing threshold, and the level of a biologically relevant sound. Masking is found among all vertebrate groups, and the auditory system in all vertebrates, including fish, is capable of limiting the effects of masking noise, especially when the frequency range of the noise and biologically relevant signal differ (Fay 1988; Fay and Megela-Simmons 1999).

The frequency of the sound is an important consideration for fish because many marine fish are limited to detection of the particle motion component of low frequency sounds at relatively high sound intensities (Amoser and Ladich 2005). The frequency of the acoustic stimuli must first be compared to the animal's known or suspected hearing sensitivity to establish if the animal can potentially detect the sound.

One of the problems with existing fish auditory masking data is that the bulk of the studies have been done with goldfish, a freshwater fish with well-developed anatomical specializations that enhance hearing abilities. The data on other species are much less extensive. As a result, less is known about masking in marine species, many of which lack the notable anatomical hearing specializations. However, Wysocki and Ladich (2005) suggest that ambient sound regimes may limit acoustic communication and orientation, especially in animals with notable hearing specializations.

Tavolga (1974a, b) studied the effects of noise on pure-tone detection in two species without notable anatomical hearing specializations, the pin fish (*Lagodon rhomboids*) and the African mouth-Breeder (*Tilapia macrocephala*), and found that the masking effect was generally a linear function of masking level, independent of frequency. In addition, Buerkle (1968, 1969) studied five frequency bandwidths for Atlantic cod in the 20 to 340 Hz region and showed masking across all hearing ranges. Chapman and Hawkins (1973) found that ambient noise at higher sea states in the ocean has masking effects in cod, *Gadus morhua* (L.), haddock, *Melanogrammus aeglefinus* (L.), and pollock, *Pollochinus pollachinus* (L.), and similar results were suggested for several sciaenid species by Ramcharitar and Popper (2004).Thus, based on limited data, it appears that for fish, as for mammals, masking may be most problematic in the frequency region near the signal.

There have been a few field studies that may suggest masking could have an impact on wild fish. Gannon et al. (2005) shows that bottlenose dolphins (*Tursiops truncatus*) move toward acoustic playbacks of the vocalization of Gulf toadfish (*Opsanus beta*). Bottlenose dolphins employ a variety of vocalizations during social communication including low-frequency pops. Toadfish may be able to best detect the low-frequency pops since their hearing is best below 1 kHz, and there is some indication that toadfish have reduced levels of calling when bottlenose dolphins approach (Remage-Healey et al. 2006). Silver perch have also been shown to decrease calls when exposed to playbacks of dolphin whistles mixed with other biological sounds (Luczkovich et al. 2000). Results of the Luczkovich et al. (2000) study, however, must be viewed with caution because it is not clear what sound may have elicited the silver perch response (Ramcharitar et al. 2006). Astrup (1999) and Mann et al. (1998) hypothesize that high frequency detecting species (e.g., clupeids) may have developed sensitivity to high frequency sounds to avoid predation by odontocetes. Therefore, the presence of masking noise may hinder a fish's ability to detect predators and therefore increase predation.

Of considerable concern is that human-generated sounds could mask the ability of fish to use communication sounds, especially when the fish are communicating over some distance. In effect, the masking sound may limit the distance over which fish can communicate, thereby having an impact on important components of their behavior. For example, the sciaenids, which are primarily inshore species, are one of the most active sound producers among fish, and the sounds produced by males are used to "call" females to breeding sights (Ramcharitar et al. 2001) reviewed in Ramcharitar (2006). If the females are not able to hear the reproductive sounds of the males, there could be a significant impact on the reproductive success of a population of sciaenids. Since most sound production in fish used for communication is generally below 500 Hz (Slabbekoorn et al. 2010), sources with significant low-frequency acoustic energy could affect communication in fish.

Also potentially vulnerable to masking is navigation by larval fish, although the data to support such an idea are still exceedingly limited. There is indication that larvae of some reef fish (species not identified in study) may have the potential to navigate to juvenile and adult habitat by listening for sounds emitted from a reef (either due to animal sounds or non-biological sources such as surf action) (e.g., Higgs 2005). In a study of an Australian reef system, the sound signature emitted from fish choruses was between 0.8 and 1.6 kHz (Cato 1978) and could be detected by hydrophones 3 to 4 nm from the reef (McCauley and Cato 2000). This bandwidth is within the detectable bandwidth of adults and larvae of the few species of reef fish, such as the damselfish, *Pomacentrus partitus,* and bicolor damselfish, *Eupomacentrus partitus,* that have been studied (Myrberg 1980; Kenyon 1996). At the same time, it has not been demonstrated conclusively that sound, or sound alone, is an attractant of larval fish to a reef, and the number of species tested has been very limited. Moreover, there is also evidence that larval fish may be using other kinds of sensory cues, such as chemical signals, instead of, or alongside of, sound (Atema et al. 2002).

3.9.3.1.1.4 Physiological Stress and Behavioral Reactions

As with masking, a fish must first be able to detect a sound above its hearing threshold for that particular frequency and the ambient noise before a behavioral reaction or physiological stress can occur. There are little data available on the behavioral reactions of fish, and almost no research conducted on any long-term behavioral effects or the potential cumulative effects from repeated exposures to loud sounds (Popper and Hastings 2009).

Stress refers to biochemical and physiological responses to increases in background sound. The initial response to an acute stimulus is a rapid release of stress hormones into the circulatory system, which may cause other responses such as elevated heart rate and blood chemistry changes. Although an increase in background sound has been shown to cause stress in humans, only a limited number of studies have measured biochemical responses by fish to acoustic stress (e.g., Smith et al. 2004b; Remage-Healey et al. 2006; Wysocki et al. 2006; Wysocki et al. 2007) and the results have varied. There is evidence that a sudden increase in sound pressure level or an increase in background noise levels can increase stress levels in fish (Popper and Hastings 2009). Exposure to acoustic energy has been shown to cause a change in hormone levels (physiological stress) and altered behavior in some species such as the goldfish (*Carassius auratus*) (Pickering 1981; Smith et al. 2004a, b), but not all species tested to date, such as the rainbow trout (*Oncorhynchus mykiss*) (Wysocki et al. 2007).

Behavioral effects to fish could include disruption or alteration of natural activities such as swimming, schooling, feeding, breeding, and migrating. Sudden changes in sound level can cause fish to dive, rise, or change swimming direction. There is a lack of studies that have investigated the behavioral reactions of unrestrained fish to anthropogenic sound. Studies of caged fish have identified three basic behavioral reactions to sound: startle, alarm, and avoidance (Pearson et al. 1992; McCauley et al. 2000; Scripps Institution of Oceanography and National Science Foundation 2008). Changes in sound intensity may be more important to a fish's behavior than the maximum sound level. Sounds that fluctuate in level tend to elicit stronger responses from fish than even stronger sounds with a continuous level (Schwartz 1985).

Non-Impulsive Acoustic Sources

Remage-Healey et al. (2006) found elevated cortisol levels, a stress hormone, in Gulf toadfish (*Opsanus beta*) exposed to low frequency bottlenose dolphin sounds. Additionally, the toadfish' call rates dropped by about 50 percent, presumably because the calls of the toadfish, a primary prey for bottlenose dolphins, give away the fish's location to the dolphin. The researchers observed none of these effects in toadfish exposed to an ambient control sound (i.e., low-frequency snapping shrimp 'pops').

Smith et al. (2004) found no increase in corticosteroid, a stress hormone, in goldfish (*Carassius auratus*) exposed to a continuous, band-limited noise (0.1 to 10 kHz) with a sound pressure level of 170 dB re 1 µPa for 1 month. Wysocki et al. (2007) exposed rainbow trout (*Onorhynchus mykiss*) to continuous band-limited noise with a sound pressure level of about 150 dB re 1 µPa for 9 months with no observed stress effects. Growth rates and effects on the trout's immune system were not significantly different from control animals held at sound pressure level of 110 dB re 1 µPa.

Gearin et al. (2000) studied responses of adult sockeye salmon (*Oncorhynchus nerka*) and sturgeon (*Acipenser* sp.) to pinger sounds produced by acoustic devices designed to deter marine mammals from gillnet fisheries. The pingers produced sounds with broadband energy with peaks at 2 kHz or 20 kHz. They found that fish did not exhibit any reaction or behavior change to the pingers, which demonstrated that the alarm was either inaudible to the salmon and sturgeon, or that neither species was disturbed by the mid-frequency sound (Gearin et al. 2000). Based on hearing threshold data, it is highly likely that the salmonids did not hear the sounds.

Culik et al. (2001) did a very limited number of experiments to determine the catch rate of herring (*Clupea harengus*) in the presence of pingers producing sounds that overlapped with the frequency range of hearing for herring (base frequency of 2.7 kHz with harmonics to 19 kHz). They found no change in catch rates in gill nets with or without the higher frequency (greater than 20 kHz) sounds present, although there was an increase in the catch rate with the signals from 2.7 kHz to 19 kHz (a different source than the higher frequency source). The results could mean that the fish did not "pay attention" to the higher frequency sound or that they did not hear it, but that lower frequency sounds may be attractive to fish. At the same time, it should be noted that there were no behavioral observations on the fish, and so how the fish actually responded when they detected the sound is not known.

Doksæter et al. (2009) studied the reactions of wild, overwintering herring to Royal Netherlands Navy experimental mid-frequency active sonar and killer whale feeding sounds. The behavior of the fish was monitored using upward looking echosounders. The received levels from the 1–2 kHz and 6–7 kHz sonar signals ranged from 127 to 197 dB re 1 µPa and 139 to 209 dB re 1 µPa, respectively. Escape reactions were not observed upon the presentation of the mid-frequency active sonar signals; however, the playback of the killer whale sounds elicited an avoidance reaction. The authors concluded that these mid-frequency sonar could be used in areas of overwintering herring without substantially affecting the fish.

There is evidence that elasmobranchs respond to human-generated sounds. Myrberg and colleagues did experiments in which they played back sounds and attracted a number of different shark species to the sound source (e.g., Myrberg et al. 1969; Myrberg et al. 1972; Nelson and Johnson 1972; Myrberg et al. 1976). The results of these studies show that sharks were attracted to low-frequency sounds (below several hundred Hz), in the same frequency range of sounds that might be produced by struggling prey. However, sharks are not known to be attracted by continuous signals or higher frequencies (which they presumably cannot hear since their best hearing sensitivity is around 20 Hz, and drops off above 1000 Hz [Casper and Mann 2006; Casper and Mann 2009]).

Studies documenting behavioral responses of fish to vessels show that Barents Sea capelin (*Mallotus villosus*) may exhibit avoidance responses to engine noise, sonar, depth finders, and fish finders (Jørgensen et al. 2004). Avoidance reactions are quite variable depending on the type of fish, its life history stage, behavior, time of day, and the sound propagation characteristics of the water (Schwartz 1985). Misund (1997) found that fish ahead of a ship, that showed avoidance reactions, did so at ranges of 160 to 490 ft. (49 to 150 m). When the vessel passed over them, some species of fish responded with sudden escape responses that included lateral avoidance or downward compression of the school.

In a study by Chapman and Hawkins (1973) the low-frequency sounds of large vessels or accelerating small vessels caused avoidance responses by herring. Avoidance ended within 10 seconds after the vessel departed. Twenty-five percent of the fish groups habituated to the sound of the large vessel and 75 percent of the responsive fish groups habituated to the sound of small boats.

Explosives and Other Impulsive Acoustic Sources

Pearson et al. (1992) exposed several species of rockfish (*Sebastes* spp.) to a seismic airgun. The investigators placed the rockfish in field enclosures and observed the fish's behavior while firing the airgun at various distances for 10-minute trials. Dependent upon the species, rockfish exhibited startle or alarm reactions between peak to peak sound pressure level of 180 dB re 1 µPa and 205 dB re 1 µPa. The authors reported the general sound level where behavioral alterations became evident was at about 161 dB re 1 µPa for all species. During all of the observations, the initial behavioral responses only lasted for a few minutes, ceasing before the end of the 10 minute trial.

Similarly, Skalski et al. (1992) show a 52 percent decrease in rockfish (*Sebastes* sp.) caught with hook-and-line (as part of the study—fisheries independent) when the area of catch was exposed to a single airgun emission at 186 to 191 dB re 1 µPa (mean peak level) (See also Pearson et al. 1987; Pearson et al. 1992). They also demonstrate that fish would show a startle response to sounds as low as 160 dB re 1 µPa, but this level of sound did not appear to elicit decline in catch. Wright (1982) also observed changes in fish behavior as a result of the sound produced by an explosion, with effects intensified in areas of hard substrate.

Wardle et al. (2001) used a video system to examine the behaviors of fish and invertebrates on reefs in response to emissions from seismic airguns. The researchers carefully calibrated the airguns to have a peak level of 210 dB re 1 µPa at 16 m (52.5 ft.) and 195 dB re 1 µPa at 109 m (357.6 ft.) from the source. There was no indication of any observed damage to the marine organisms. They found no substantial or permanent changes in the behavior of the fish or invertebrates on the reef throughout the course of the study, and no marine organisms appeared to leave the reef.

Engås et al. (1996) and Engås and Løkkeborg (2002) examined movement of fish during and after a seismic airgun study by measuring catch rates of haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*) as an indicator of fish behavior using both trawls and long-lines as part of the experiment. These investigators found a significant decline in catch of both species that lasted for several days after termination of airgun use. Catch rate subsequently returned to normal. The conclusion reached by the investigators was that the decline in catch rate resulted from the fish moving away from the airgun sounds at the fishing site. However, the investigators did not actually observe behavior, and it is possible that the fish just changed depth.

The same research group showed, more recently, parallel results for several additional pelagic species including blue whiting and Norwegian spring spawning herring (Slotte et al. 2004). However, unlike earlier studies from this group, the researchers used fishing sonar to observe behavior of the local fish schools. They reported that fish in the area of the airguns appeared to go to greater depths after the airgun exposure compared to their vertical position prior to the airgun usage. Moreover, the abundance of animals 30 to 50 km (18.6 to 31.1 mi.) away from the ensonification increased, suggesting that migrating fish would not enter the zone of seismic activity.

Alteration in natural behavior patterns due to exposure to pile driving noise has not been well studied. However, one study (Mueller-Blenkle et al. 2010) demonstrates behavioral reactions of cod (*Gadus morhua*) and Dover sole (*Solea solea*) to pile driving noise. Sole showed a significant increase in swimming speed. Cod reacted, but not significantly, and both species showed directed movement away from the sources with signs of habituation after multiple exposures. For sole, reactions were seen with peak sound pressure levels of 144 to 156 dB re 1 µPa; and cod showed altered behavior at peak sound pressure levels of 140 to 161 dB re 1 µPa. For both species, this corresponds to a peak particle motion between 6.51 x 10^{-3} and 8.62 x 10^{-4} meters per second squared.

3.9.3.1.2 Impacts from Sonar and Other Active Sources

Non-impulse sources from the Proposed Action include sonar and other active acoustic sources, vessel noise, and subsonic aircraft noise. Potential acoustic effects to fish from non-impulse sources may be considered in four categories, as detailed above in Section 3.9.3.1.1 (Analysis Background and Framework): (1) direct injury, (2) hearing loss, (3) auditory masking, and (4) physiological stress and behavioral reactions.

As discussed in Section 3.9.3.1.1.1 (Direct Injury), direct injury to fish as a result of exposure to non-impulse sounds is highly unlikely to occur. Therefore, direct injury as a result of exposure to non-impulse sound sources is not discussed further in this analysis.

Research discussed in Section 3.9.3.1.1.2 (Hearing Loss), indicates that exposure of fish to transient, non-impulse sources is unlikely to result in any hearing loss. Most sonar sources are outside of the hearing and sensitivity range of most marine fish, and noise sources such as vessel movement and aircraft overflight lack the duration and intensity to cause hearing loss. Furthermore, PTS has not been demonstrated in fish as they have been shown to regenerate lost sensory hair cells. Therefore, hearing loss as a result of exposure to non-impulse sound sources is not discussed further in this analysis.

3.9.3.1.2.1 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 Non-Impulse Sources), training activities under the No Action Alternative include activities that produce in-water sound from the use of sonar and other active acoustic sources, and could occur throughout the Study Area. Sonar and other active acoustic sources proposed for use are transient in most locations as active sonar activities pass through the Study Area. Based on current research, only a few species of shad within the Clupeidae family (herrings) are known to be able to detect high-frequency sonar and other active acoustic sources (greater than 10,000 Hz). Other marine fish would probably not detect these sounds and would therefore experience no stress, behavioral disturbance, or auditory masking. Shad species, especially in nearshore and inland areas where mine warfare activities take place that often employ high-frequency sonar systems, could have behavioral reactions and experience auditory masking during these activities. However, mine warfare activities are typically limited in duration and geographic extent. Furthermore, sound from high-frequency systems may only be detectable above ambient noise regimes in these coastal habitats from within a few kilometers. Behavioral reactions and auditory masking if they occurred for some shad species are expected to be transient. Long-term consequences for the population would not be expected.

The fish species that are known to detect mid-frequencies (some sciaenids [drum], most clupeids [herring], and potentially deep-water fish such as myctophids [lanternfish]) do not have their best sensitivities in the range of the operational sonar (see Chapter 3, Affected Environment and Environmental Consequences, for more details). Thus, these fish may only detect the most powerful systems, such as hull mounted sonar within a few kilometers; and most other, less powerful mid-frequency sonar systems, for a kilometer or less. Due to the limited time of exposure due to the moving sound sources, most mid-frequency active sonar used in the Study Area would not have the potential to substantially mask key environmental sounds or produce sustained physiological stress or behavioral reactions. Furthermore, although some species may be able to produce sound at higher frequencies (greater than 1 kHz), vocal marine fish, such as sciaenids, largely communicate below the range of mid-frequency levels used by most sonar. However, any such effects would be temporary and infrequent as a vessel operating mid-frequency sonar transits an area. As such, sonar use is unlikely to impact fish species. Long-term consequences for fish populations due to exposure to mid-frequency sonar and other active acoustic sources are not expected.

Vessel Noise

As discussed in Section 3.0.5.3.1.5 (Vessel Noise), training activities under the No Action Alternative include vessel movement. Navy vessel traffic could occur anywhere within the Study Area; however, it would be concentrated near ports or naval installations and training ranges. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to 2 weeks. Additionally, a variety of smaller craft would be operated within the Study Area. Small craft types, sizes and speeds vary. These activities would be spread across the coastal and open ocean areas designated within the Study Area. Vessel movements involve transit 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).

A detailed description of vessel noise associated with the proposed action is provided in Section 3.0.5.3.1.5 (Vessel Noise). Vessel noise has the potential to expose fish to sound and general disturbance, which could result in short-term behavioral or physiological responses (e.g., avoidance, stress, increased heart rate). Training and testing activities involving vessel movements occur intermittently and range in duration from a few hours up to a few weeks. These activities are widely dispersed throughout the Study Area. While vessel movements have the potential to expose fish occupying the water column to sound and general disturbance, potentially resulting in short-term behavioral or physiological responses, such responses would not be expected to compromise the general health or condition of individual fish. In addition, most activities involving vessel movements are infrequent and widely dispersed throughout the Study Area. The exception is for pierside activities, although these areas are located in inshore, these are industrialized areas that are already exposed to high levels of anthropogenic noise due to numerous waterfront users (e.g., industrial and marinas). Therefore, impacts from vessel noise would be temporary and localized. Long-term consequences for the population are not expected.

Aircraft Noise

As described in Section 3.0.5.3.1.6 (Aircraft Overflight Noise), 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 activities would be spread across the coastal and open ocean areas designated within the Study Area. A detailed description of aircraft noise as a stressor is provided in Section 3.0.5.3.1.6 (Aircraft Overflight Noise). 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). Most fixed-wing aircraft sorties would occur above 3,000 ft. (900 m). Exposure to fixed-wing aircraft noise would be brief (seconds) as an aircraft quickly passes overhead.

Fish may be exposed to aircraft-generated noise wherever aircraft overflights occur; however, sound is primarily transferred into the water from air in a narrow cone under the aircraft. Most of these sounds would occur near airbases and fixed ranges within each range complex. Some species of fish could respond to noise associated with low-altitude aircraft overflights or to the surface disturbance created by downdrafts from helicopters. Aircraft overflights have the potential to affect surface waters and, therefore, to expose fish occupying those upper portions of the water column to sound and general disturbance potentially resulting in short-term behavioral or physiological responses. If fish were to respond to aircraft overflights, only short-term behavioral or physiological reactions (e.g., temporarily swimming away and increased heart rate) would be expected. Therefore, long-term consequences for individuals would be unlikely and long-term consequences for the populations are not expected.

3.9.3.1.2.2 No Action Alternative – Testing Activities

Testing activities potentially using non-impulse acoustic sources under the No Action Alternative are restricted to the North Pacific Acoustic Lab Philippine Sea Experiment (Table 2.8-4). Research vessels, acoustic test sources, side scan sonar, ocean gliders, the existing moored acoustic topographic array and distributed vertical line array, and other oceanographic data collection equipment will be used to collect information on the ocean environment and sound propagation during the 2018 data collection period. Currently, the array is being used to passively collect oceanographic and acoustic data in the region. Therefore, impacts to fish due to non-impulse sound are expected to be limited to short-term, minor behavioral reactions. Long-term consequences for populations would not be expected.

3.9.3.1.2.3 Alternative 1 – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Chapter 3 (Affected Environment and Environmental Consequences), the number of annual training activities that produce in-water sound from the use of sonar and other active acoustic sources under Alternative 1 would increase; however, the locations, types, and severity of impacts would not be discernable from those described above in Section 3.9.3.1.2.1 (No Action Alternative – Training). Under Alternative 1, there will be the additional use of low-frequency sonar. A large number of marine fish species may be able to detect low-frequency sonar and other active acoustic sources. However, low-frequency active usage is rare and most low-frequency active operations are conducted in deeper waters, usually beyond the continental shelf break. The majority of fish species, including those that are the most highly vocal, exist on the continental shelf and within nearshore, estuarine areas. Fish within several dozen kilometers around a low-frequency active sonar could experience brief periods of masking, physiological stress, and behavioral disturbance while the system is used, with effects most pronounced closer to the source. However, overall effects would be localized and infrequent. Based on the low level and short duration of potential exposure to low-frequency sonar and other active acoustic sources, long-term consequences for fish populations are not expected. As discussed in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.5 (Vessel Noise), training activities, under Alternative 1 include an increase in the numbers of activities that involve vessels compared to 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; however, the locations, types, and severity of impacts would not be discernable from those described above in Section 3.9.3.1.2.1 (No Action Alternative – Training).

As discussed in Chapter 2 (Description of Proposed Action And Alternatives), Table 2.8-1, and Section 3.0.5.3.1.6 (Aircraft Overflight Noise), training activities under Alternative 1 include an increase in the number of activities that involve aircraft as 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; however, the locations, types, and severity of impacts would not be discernable from those described above in Section 3.9.3.1.2.1 (No Action Alternative – Training).

Despite the increase in activity, the potential effects of training activities involving sonar and other active acoustic sources under Alternative 1 on fish species would be similar to those described above for training activities under the No Action Alternative, and are expected to be limited to short-term, minor behavioral reactions. Effects to fish populations would not occur as a result of non-impulse sounds associated with training activities under Alternative 1.

3.9.3.1.2.4 Alternative 1 – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-4, and Section 3.0.5.3.1 (Acoustic Stressors), the number of annual testing activities that produce sound from vessels and aircraft, and the use of sonar and other active acoustic sources, analyzed under Alternative 1 would increase over what was analyzed for the No Action Alternative. These activities would happen in the same general locations under Alternative 1 as described under the Alternative 1 – Training.

The primary exposure to vessel and aircraft noise would occur around ports and air bases. Vessel and aircraft overflight noise have the potential to expose fish to sound and general disturbance, potentially resulting in short-term behavioral responses. However, as discussed above, any short-term behavioral reactions, physiological stress, or auditory masking is unlikely to lead to long-term consequences for individuals. Therefore, long-term consequences for populations are not expected.

Despite the increase in activity, the potential effects of testing activities involving sonar and other active acoustic sources under Alternative 1 on fish species would be similar to those described above for training activities under the No Action Alternative, and are expected to be limited to short-term, minor behavioral reactions. Effects to fish populations would not occur as a result of non-impulse sounds associated with testing activities under Alternative 1.

3.9.3.1.2.5 Alternative 2 – Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Chapter 3 (Affected Environment and Environmental Consequences), the number of annual training activities that produce noise from vessels and aircraft, and the use of sonar and other active acoustic sources under Alternative 2 would increase; however, the locations, types, and severity of impacts would not be discernable from those described above in Section 3.9.3.1.2.1 (No Action Alternative – Training).

As discussed in Chapter 2 (Description of Proposed Action and Alternatives), Table 2.8-1, and Section 3.0.5.3.1.5 (Vessel Noise), training activities, under Alternative 2 include an increase in the numbers of activities that involve vessels compared to the No Action Alternative; however, the locations and predicted impacts would not differ. Proposed training activities under Alternative 2 that involve vessel movement differ in number from training activities proposed under the No Action Alternative; however, the locations, types, and severity of impacts would not be discernable from those described above in Section 3.9.3.1.2.1 (No Action Alternative – Training).

As discussed in Chapter 2 (Description of Proposed Action And Alternatives), Table 2.8-1, and Section 3.0.5.3.1.6 (Aircraft Overflight Noise), training activities under Alternative 2 include an increase in the number of activities that involve aircraft as 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 2 aircraft overflight noise may increase; however, the locations, types, and severity of impacts would not be discernable from those described above in Section 3.9.3.1.2.1 (No Action Alternative – Training).

Despite the increase in activity, the potential effects of training activities involving sonar and other active acoustic sources under Alternative 2 on fish species would be similar to those described above for training activities under the No Action Alternative, and are expected to be limited to short-term, minor behavioral reactions. Effects to fish populations would not occur as a result of non-impulse sounds associated with training activities under Alternative 2.

3.9.3.1.2.6 Alternative 2 – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-4, and Section 3.0.5.3.1 (Acoustic Stressors), the number of annual testing activities that produce in-water sound from the use of sonar and other active acoustic sources analyzed under Alternative 2 would increase over what was analyzed for the No Action Alternative. These activities would happen in the same general locations under Alternative 2 as described under Alternative 2 in Section 3.9.3.1.2.5 (Alternative 2 – Training).

The primary exposure to vessel and aircraft noise would occur around ports and air bases. Vessel and aircraft overflight noise have the potential to expose fish to sound and general disturbance, potentially resulting in short-term behavioral responses. However, as discussed above, any short-term behavioral reactions, physiological stress, or auditory masking is unlikely to lead to long-term consequences for individuals. Therefore, long-term consequences for populations are not expected.

Despite the increase in activity, the potential effects of testing activities involving sonar and other active acoustic sources under Alternative 2 on fish species would be similar to those described above for training activities under the No Action Alternative, and are expected to be limited to short-term, minor behavioral reactions. No population level effects on fish are expected as a result of non-impulse sounds associated with testing activities under Alternative 2.

3.9.3.1.2.7 Conclusions – Impacts on Fish from Non-Impulse Sound Sources

The majority of fish species exposed to non-impulse sound sources would likely have no reaction or mild behavioral reactions. Overall, long-term consequences for individual fish are unlikely in most cases because acoustic exposures are intermittent and unlikely to repeat over short periods. Since long-term consequences for most individuals are unlikely, long-term consequences for populations are not expected.

3.9.3.1.3 Impacts from Explosives and Other Impulsive Sound Sources

Explosions and other impulse sound sources include explosions from underwater detonations and explosive ordnance, swimmer defense airguns, and noise from weapons firing, launch, and impact with the water's surface. Potential acoustic effects to fish from impulse sound sources may be considered in four categories, as detailed above in Section 3.9.3.1 (Acoustic Stressors): (1) direct injury, (2) hearing loss, (3) auditory masking, and (4) physiological stress and behavioral reactions.

Potential impacts on fish from explosions and impulse sound sources can range from brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin and Hempen 1997).

Animals that experience hearing loss (permanent or temporary threshold shift) as a result of exposure to explosions and impulse sound sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. It is uncertain whether some permanent hearing loss over a part of a fish's hearing range would have long-term consequences for that individual. If this did affect the fitness (reproductive success) of a few individuals, it is unlikely to have long-term consequences for the population.

Occasional behavioral reactions to intermittent explosions and impulse sound sources are unlikely to cause long-term consequences for individual fish or populations.

Explosives

Concern about potential fish mortality associated with the use of at-sea explosives led military researchers to develop mathematical and computer models that predict safe ranges for fish and other animals from explosions of various sizes (e.g., Yelverton et al. 1975, Goertner 1982, Goertner et al. 1994). Young (1991) provides equations that allow estimation of the potential effect of underwater explosions on fish possessing swim bladders using a damage prediction method developed by Goertner (1982). Young's parameters include the size of the fish and its location relative to the explosive source, but are independent of environmental conditions (e.g., depth of fish and explosive shot frequency). An example of such model predictions is shown in Table 3.9-4, which lists estimated explosive-effects ranges using Young's (1991) method for fish possessing swim bladders exposed to explosions that would typically occur during training exercises. The 10 percent mortality range is the distance beyond which 90 percent of the fish present would be expected to survive. It is difficult to predict the range of more subtle effects causing injury but not mortality (CSA 2004).

Table 3.9-4: Estimated Explosive Effects Ranges for Fish with Swim Bladders

Training Operation and Type of Ordnance	Net Explosive Weight (lb.)	Depth of Explosion (ft.)	10% Mortality Range (ft.)		
			1 oz. Fish	1 lb. Fish	30 lb. Fish
Mine Neutralization					
MK 103 Charge	0.002	10	40	28	18
AMNS Charge	3.24	20	366	255	164
20 lb. NEW UNDET Charge	20	30	666	464	299
Missile Exercise					
Hellfire	8	3.3	317	221	142
Maverick	100	3.3	643	449	288
Firing Exercise with IMPASS					
Explosive Naval Gun Shell, 5-inch	8	1	244	170	109
Bombing Exercise					
MK 20	109.7	3.3	660	460	296
MK 82	192.2	3.3	772	539	346
MK 83	415.8	3.3	959	668	430
MK 84	945	3.3	1,206	841	541

Notes: NEW = Net Explosive Weight, lb. = pound, ft. = foot/feet, oz. = ounce

Fish not killed or driven from a location by an explosion might change their behavior, feeding pattern, or distribution. Changes in behavior of fish have been observed as a result of sound produced by explosives, with effect intensified in areas of hard substrate (Wright 1982). Stunning from pressure waves could also temporarily immobilize fish, making them more susceptible to predation.

The number of fish killed by an underwater explosion would depend on the population density in the vicinity of the blast, as well as factors discussed above such as net explosive weight, depth of the explosion, and fish size. For example, if an explosion occurred in the middle of a dense school of fish, a large number of fish could be killed. Furthermore, the probability of this occurring is low based on the patchy distribution of dense schooling fish.

Sounds from explosions could cause hearing loss in nearby fish (dependent upon charge size). Permanent hearing loss has not been demonstrated in fish, as lost sensory hair cells can be replaced unlike in mammals. Fish that experience hearing loss could miss opportunities to detect predators or prey, or reduce interspecific communication. If an individual fish were repeatedly exposed to sounds from underwater explosions that caused alterations in natural behavioral patterns or physiological stress, these impacts could lead to long-term consequences for the individual such as reduced survival, growth, or reproductive capacity. However, the time scale of individual explosions is very limited, and training exercises involving explosions are dispersed in space and time. Consequently, repeated exposure of individual fish to sounds from underwater explosions is not likely and most acoustic effects are expected to be short-term and localized. Long-term consequences for populations would not be expected.

Weapons Firing, Launch, and Impact Noise

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, and non-explosive ordnance impact with the water's surface. Activities are spread throughout the Study Area, and could take place within coastal or open ocean areas. Most activities involving large-caliber naval gunfire or the launching of targets, missiles, bombs, or other ordnance are conducted greater than 12 nm from shore.

A detailed description of weapons firing, launch, and impact noise is provided in Section 3.0.5.3.1.4 (Weapons Firing, Launch, and Impact Noise). Noise under the muzzle blast of a 5 in. (12.7 cm) gun and directly under the flight path of the shell (assuming the shell is a few meters above the water's surface) would produce a peak sound pressure level of approximately 200 dB re 1 µPa near the surface of the water (1 to 2 m [3.3 to 6.6 ft.] depth). Sound due to missile and target launches is typically at a maximum during initiation of the booster rocket and rapidly fades as the missile or target travels downrange. 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. Mines, non-explosive bombs, and intact missiles and targets could impact the water with great force and produce a large impulse and loud noise of up to approximately 270 dB re 1 µPa at 1 m (3.3 ft.), but with very short pulse durations, depending on the size, weight, and speed of the object at impact (McLennan 1997). This corresponds to sound exposure levels of around 200 dB re 1 μPa^2-s at 1 m (3.3 ft.). These sounds from weapons firing launch, and impact noise would be transient and of short duration, lasting no more than a few seconds at any given location.

Fish that are exposed to noise from weapons firing, launch, and non-explosive ordnance impact with the water's surface may exhibit brief behavioral reactions; however, due to the short term, transient nature of weapons firing, launch, and non-explosive impact noise, animals are unlikely to be exposed multiple times within a short period. Behavioral reactions would likely be short term (minutes) and substantive costs or long-term consequences for individuals or populations would not be expected.

3.9.3.1.3.1 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 ordnance. Training activities involving explosions could be conducted throughout the Study Area, although activities do not normally occur within 3 nm of shore except at designated underwater detonation areas.

Under the No Action Alternative, explosive bombs (32), missiles/rockets (58), explosives sonobouys (8), and large-caliber projectiles (1,240) are proposed to be expended during training activities in the Study Area (see Table 3.0-19). As described above, impacts from weapons firing, launch, and impact noise would likely be short term (minutes) and substantive costs or long-term consequences for individuals or populations would not be expected. Additionally, individuals are unlikely to be exposed multiple times within a short period.

3.9.3.1.3.2 No Action Alternative – Testing Activities

Testing activities under the No Action Alternative do not involve the use of impulse sources.

3.9.3.1.3.3 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 explosions under Alternative 1 would increase. Under Alternative 1, explosive bombs (212), missiles/rockets (227), large- and medium-caliber projectiles (9,550), and explosive sonobuoys (11) are proposed to be expended during training activities in the Study Area (see Table 3.0-19 for details), which would be a 560 percent increase over the No Action Alternative. As described above, impacts from weapons firing, launch, and impact noise would likely be short term (minutes) and substantive costs or long-term consequences for individuals or populations would not be expected. Additionally, individuals are unlikely to be exposed multiple times within a short period. These activities would happen in the same general locations as described by the No Action Alternative.

As discussed for the No Action Alternative, potential impacts on fish from explosions and impulse sound sources can range from no effect, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin and Hempen 1997). Occasional behavioral reactions to intermittent explosions and impulse sound sources are unlikely to cause long-term consequences for individual fish or populations. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use, despite the increase in activities under Alternative 1, the activities are infrequent and widely dispersed throughout the Study Area, and the distribution of potentially affected fishes also varies, impacts from at-sea explosion from training activities would be temporary and localized, and are not expected to result in population level impacts.

3.9.3.1.3.4 Alternative 1 –Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-4, and Section 3.0.5.3.1.2 (Explosives), the number of annual testing activities that use explosives under Alternative 1 would increase over the No Action Alternative (see Table 3.0-9 for details). Testing activities involving explosions could be conducted throughout the Study Area, although activities do not normally occur within 3 nm of shore except at designated underwater detonation areas. As described above, impacts from weapons firing, launch, and impact noise would likely be short term (minutes) and substantive costs or long-term consequences for individuals or populations would not be expected.

Additionally, individuals are unlikely to be exposed multiple times within a short period. These testing activities are spread throughout the Study Area, and described in Tables 2.8-2 to 2.8-4.

Swimmer Defense Airguns

Testing activities under Alternative 1 would include the use of swimmer defense airguns up in Inner Apra Harbor as described in Section 3.0.5.3.1.3 (Swimmer Defense Airguns). Source levels are estimated to be 185 to 195 dB re 1 μPa^2-s at 1 m. For 100 shots, the cumulative sound exposure level would be approximately 215 to 225 dB re 1 μPa^2-s at 1 m.

Single, small airguns (60 cubic inches) are unlikely to cause direct trauma to marine fish. 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. As discussed in Section 3.9.3.1.1.1 (Direct Injury), there is little evidence that airguns can cause direct injury to adult fish, with the possible exception of injuring small juvenile or larval fish nearby (approximately 16 ft. [4.9 m]). Therefore, larval and small juvenile fish within a few meters of the airgun may be injured or killed. Considering the small footprint of this hypothesized injury zone, and the isolated and infrequent use of the swimmer defense airgun, population consequences would not be expected.

As discussed in Section 3.9.3.1.1.2 (Hearing Loss), temporary hearing loss in fish could occur if fish were exposed to impulses from swimmer defense airguns, although some studies have shown no hearing loss from exposure to airguns within 16 ft. (4.9 m). Therefore, fish within a few meters of the airgun may receive temporary hearing loss. However, due to the relatively small size of the airgun, and their limited use in pierside areas, impacts would be minor, and may only impact a few individual fish. Population consequences would not be expected.

Airguns do produce broadband sounds; however, the duration of an individual impulse is about one-tenth of a second. Airguns could be fired up to 100 times per activity, 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 have high levels of ambient noise, see Appendix I (Acoustic and Explosives Primer). Auditory masking is discussed in Section 3.9.3.1.1.3 (Auditory Masking), and only occurs when the interfering signal is present. Due to the limited duration of individual shots and the limited number of shots proposed for the swimmer defense airgun, only brief, isolated auditory masking to marine fish would be expected. Population consequences would not be expected.

In addition, fish that are able to detect the airgun impulses may exhibit alterations in natural behavior. As discussed in Section 3.9.3.1.1.4 (Physiological Stress and Behavioral Reactions), some fish species with site fidelity such as reef fish may show initial startle reactions, returning to normal behavioral patterns within a matter of a few minutes. Pelagic and schooling fish that typically show less site fidelity may avoid the immediate area for the duration of the activities. Due to the limited use and relatively small footprint of swimmer defense airguns, impacts to fish are expected to be minor. Population consequences would not be expected.

Conclusion

As discussed for training activities, potential impacts on fish from explosions and impulsive acoustic sources can range from no impact, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin et al. 1997).

Occasional behavioral reactions to intermittent explosives and impulsive acoustic sources are unlikely to cause long-term consequences for individual fish or populations.

Animals that experience hearing loss (permanent or temporary threshold shift) as a result of exposure to explosions and impulsive acoustic sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. It is uncertain whether some permanent hearing loss over a part of a fish's hearing range would have long-term consequences for that individual. If this did affect the fitness of a few individuals, it is unlikely to have long-term consequences for the population.

It is possible for fish to be injured or killed by an explosion; however, long-term consequences for a loss of a few individuals are unlikely to have measureable impacts on overall stocks or populations. Therefore, long-term consequences to fish populations would not be expected.

3.9.3.1.3.5 Alternative 2 – 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 explosions under Alternative 2 would increase. Under Alternative 2, explosive torpedoes (2), explosive bombs (212), missiles/rockets (505), large- and medium-caliber projectiles (9,550), and explosive sonobuoys (11) are proposed to be expended during training activities in the Study Area (see Table 3.0-19), which would be a 580 percent increase over the No Action Alternative. As described above, impacts from weapons firing, launch, and impact noise would likely be short term (minutes) and substantive costs or long-term consequences for individuals or populations would not be expected. Additionally, individuals are unlikely to be exposed multiple times within a short period. These activities would happen in the same general locations as described by the No Action Alternative.

As discussed for Alternative 1, potential impacts on fish from explosions and impulse sound sources can range from no effect, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin and Hempen 1997). Occasional behavioral reactions to intermittent explosions and impulse sound sources are unlikely to cause long-term consequences for individual fish or populations. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use, the activities are infrequent and widely dispersed throughout the Study Area, and the distribution of potentially affected fishes also varies, impacts from at-sea explosion from training activities would be temporary and localized, and are not expected to result in population level impacts.

3.9.3.1.3.6 Alternative 2 – Testing Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-2 to 2.8-4, and Section 3.0.5.3.1.2 (Explosives), the number of annual testing activities that use explosives under Alternative 2 would increase over the No Action Alternative (see Table 3.0-9). Testing activities involving explosions could be conducted throughout the Study Area, although activities do not normally occur within 3 nm of shore except at designated underwater detonation areas. As described above, impacts from weapons firing, launch, and impact noise would likely be short term (minutes) and substantive costs or long-term consequences for individuals or populations would not be expected. Additionally, individuals are unlikely to be exposed multiple times within a short period. These activities are spread throughout the Study Area and described in Tables 2.8-2–2.8-4.

Swimmer Defense Airguns

Testing activities under Alternative 2 would include the use of swimmer defense airguns up in Inner Apra Harbor as described in Section 3.0.5.3.1.3 (Swimmer Defense Airguns). Source levels are estimated to be 185 to 195 dB re 1 μPa^2-s at 1 m. For 100 shots, the cumulative sound exposure level would be approximately 215 to 225 dB re 1 μPa^2-s at 1 m.

Single, small airguns (60 $in.^3$) are unlikely to cause direct trauma to marine fish. 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. As discussed in Section 3.9.3.1.1.1 (Direct Injury), there is little evidence that airguns can cause direct injury to adult fish, with the possible exception of injuring small juvenile or larval fish nearby (approximately 16 ft. [4.9 m]). Therefore, larval and small juvenile fish within a few meters of the airgun may be injured or killed. Considering the small footprint of this hypothesized injury zone, and the isolated and infrequent use of the swimmer defense airgun, population consequences would not be expected.

As discussed in Section 3.9.3.1.1.2 (Hearing Loss), temporary hearing loss in fish could occur if fish were exposed to impulses from swimmer defense airguns, although some studies have shown no hearing loss from exposure to airguns within 16 ft. (4.9 m). Therefore, fish within a few meters of the airgun may receive temporary hearing loss. However, due to the relatively small size of the airgun, and their limited use in pierside areas, impacts would be minor, and may only impact a few individual fish. Population consequences would not be expected.

Airguns do produce broadband sounds; however, the duration of an individual impulse is about one-tenth of a second. Airguns could be fired up to 100 times per activity, 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 have high levels of ambient noise, see Appendix I (Acoustic and Explosives Primer). Auditory masking is discussed in Section 3.9.3.1.1.3 (Auditory Masking), and only occurs when the interfering signal is present. Due to the limited duration of individual shots and the limited number of shots proposed for the swimmer defense airgun, only brief, isolated auditory masking to marine fish would be expected. Population consequences would not be expected.

In addition, fish that are able to detect the airgun impulses may exhibit alterations in natural behavior. As discussed in Section 3.9.3.1.1.4 (Physiological Stress and Behavioral Reactions), some fish species with site fidelity such as reef fish may show initial startle reactions, returning to normal behavioral patterns within a matter of a few minutes. Pelagic and schooling fish that typically show less site fidelity may avoid the immediate area for the duration of the activities. Due to the limited use and relatively small footprint of swimmer defense airguns, impacts to fish are expected to be minor. Population consequences would not be expected.

Conclusion

As discussed for training activities, potential impacts on fish from explosions and impulsive acoustic sources can range from no impact, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin et al. 1997). Occasional behavioral reactions to intermittent explosives and impulsive acoustic sources are unlikely to cause long-term consequences for individual fish or populations.

Animals that experience hearing loss (permanent or temporary threshold shift) as a result of exposure to explosions and impulsive acoustic sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. It is uncertain whether some permanent hearing loss over a part of a fish's hearing range would have long-term consequences for that individual. If this did affect the fitness of a few individuals, it is unlikely to have long-term consequences for the population.

It is possible for fish to be injured or killed by an explosion; however, long-term consequences for a loss of a few individuals are unlikely to have measureable impacts on overall stocks or populations. Therefore, long-term consequences to fish populations would not be expected.

3.9.3.1.3.7 Summary of Effects to Marine Fish from Acoustic Stressors

Under the No Action Alternative, Alternative 1, or Alternative 2, potential impacts on fish from acoustic stressors can range from no impact, brief acoustic effects, tactile perception, and physical discomfort, to slight injury to internal organs and the auditory system, to death of the animal (Keevin and Hempen 1997). Occasional behavioral reactions to intermittent explosions and impulse sound sources are unlikely to cause long-term consequences for individual fish or populations. While serious injury or mortality to individual fish would be expected if they were present in the immediate vicinity of explosive ordnance use; however, population level impacts are not expected.

3.9.3.2 Energy Stressors

This section evaluates the potential for fishes to be impacted by electromagnetic devices used during training and testing activities in the Study. No high-energy lasers are used in the MITT Study Area, so the discussion of energy stressors will be restricted to electromagnetic stressors.

3.9.3.2.1 Impacts from Electromagnetic Devices

Several different electromagnetic devices are used during training and testing activities. A discussion of the type, number, and location of activities using these devices under each alternative is presented in Section 3.0.5.3.2.1 (Electromagnetic Devices).

A comprehensive review of information regarding the sensitivity of marine organisms to electric and magnetic fields, including fishes comprising the subclass elasmobranchii (sharks, skates, and rays), as well as other bony fishes, is presented in Normandeau (2011). The synthesis of available data and information contained in this report suggests that while many fish species (particularly elasmobranchs) are sensitive to electromagnetic fields, further investigation is necessary to understand the physiological response and magnitude of the potential effects. This study also highlights investigations into which electric and magnetic field strengths initiate biological and physiological responses on specific fish species (Normandeau et al. 2011). Most examinations of electromagnetic fields on marine fishes have focused on buried undersea cables associated with offshore wind farms in European waters (Boehlert and Gill 2010; Gill 2005; Ohman et al. 2007). By comparison, in the Study Area, electromagnetic devices simply mimic the electromagnetic signature of a vessel passing through the water, and none of these devices include any type of electromagnetic "pulse."

Many fish groups including lamprey, elasmobranchs, eels, salmonids, stargazers, and others, have an acute sensitivity to electrical fields, known as electroreception (Bullock et al. 1983; Helfman et al. 2009b). Electroreceptors are thought to aid in navigation, orientation, and migration of sharks and rays (Kalmijn 2000). In elasmobranchs, behavioral and physiological response to electromagnetic stimulus varies by species and age, and appears to be related to foraging behavior (Rigg et al. 2009). Many elasmobranchs respond physiologically to electric fields of 10 nanovolts (nV) per cm and behaviorally at

5 nV per cm (Collin and Whitehead 2004). Electroreceptive marine fishes with ampullary (pouch) organs can detect considerably higher frequencies of 50 Hz to more than 2 kHz (Helfman et al. 2009b). The distribution of electroreceptors on the head of these fishes, especially around the mouth suggests that these sensory organs may be used in foraging. Additionally, some researchers hypothesize that the electroreceptors aid in social communication (Collin and Whitehead 2004). The ampullae of some fishes are sensitive to low frequencies (< 0.1 to 25 Hz) of electrical energy (Helfman et al. 2009b), which may be of physical or biological origin, such as muscle contractions. For example, the ampullae of the shovelnose sturgeon (*Scaphirhynchus platorynchus*), were shown to respond to electromagnetic stimuli in a way comparable to the well-studied elasmobranchs, which are sensitive to electric fields as low as 1 microvolt (μV) per cm with a magnetic field of 100 gauss (Bleckmann and Zelick 2009).

While elasmobranchs and other fishes can sense the level of the earth's electromagnetic field, the potential effects on fish resulting from changes in the strength or orientation of the background field are not well understood. When the electromagnetic field is enhanced or altered, sensitive fishes may experience an interruption or disturbance in normal sensory perception. Research on the electrosensitivity of sharks indicates that some species respond to electrical impulses with an apparent avoidance reaction (Helfman et al. 2009b; Kalmijn 2000). This avoidance response has been exploited as a shark deterrent, to repel sharks from areas of overlap with human activity (Marcotte and Lowe 2008).

Experiments with electromagnetic pulses can provide indirect evidence of the range of sensitivity of fishes to similar stimuli. Two studies reported that exposure to electromagnetic pulses do not have any effect on fishes (Hartwell et al. 1991; Nemeth and Hocutt 1990). The observed 48-hour mortality of small estuarine fishes (sheepshead minnow, mummichog, Atlantic menhaden, striped bass, Atlantic silverside, fourspine stickleback, and rainwater killifish) exposed to electromagnetic pulses of 100 to 200 kilovolts (kV) per m (10 nanoseconds per pulse) from distances greater than 164 ft. (50 m) was not statistically different than the control group (Hartwell et al. 1991; Nemeth and Hocutt 1990). During a study of Atlantic menhaden, there were no statistical differences in swimming speed and direction (toward or away from the electromagnetic pulse source) between a group of individuals exposed to electromagnetic pulses and the control group (Hartwell et al. 1991; Nemeth and Hocutt 1990).

Both laboratory and field studies confirm that elasmobranchs (and some teleost [bony] fishes) are sensitive to electromagnetic fields, but the long-term impacts are not well-known. Electromagnetic sensitivity in some marine fishes (e.g., salmonids) is already well-developed at early life stages (Ohman et al. 2007), with sensitivities reported as low as 0.6 millivolt per centimeter (mV/cm) in Atlantic salmon (Formicki et al. 2004); however, most of the limited research that has occurred focuses on adults. Some species appear to be attracted to undersea cables, while others show avoidance (Ohman et al. 2007). Under controlled laboratory conditions, the scalloped hammerhead (*Sphyrna lewini*) and sandbar shark (*Carcharhinus plumbeus*) exhibited altered swimming and feeding behaviors in response to very weak electric fields (less than 1 nV per cm) (Kajiura and Holland 2002). In a test of sensitivity to fixed magnets, five Pacific sharks were shown to react to magnetic field strengths of 25 to 234 gauss at distances ranging between 0.85 and 1.90 ft. (0.26 and 0.58 m) and avoid the area (Rigg et al. 2009). A field trial in the Florida Keys demonstrated that southern stingray (*Dasyatis americana*) and nurse shark (*Ginglymostoma cirratum*) detected and avoided a fixed magnetic field producing a flux of 950 gauss (O'Connell et al. 2010).

Potential impacts of electromagnetic activity on adult fishes may not be relevant to early life stages (eggs, larvae, juveniles) due to ontogenic (lifestage-based) shifts in habitat utilization (Botsford et al. 2009; Sabates et al. 2007). Some skates and rays produce egg cases that occur on the bottom, while many neonate and adult sharks occur in the water column or near the water surface. Other species may have an opposite life history, with egg and larval stages occurring near the water surface, while adults may be demersal.

Based on current literature, only the fish groups identified above as capable of detecting electromagnetic fields (primarily elasmobranchs, tuna, and eels) will be carried forward in this analysis and the remaining groups (from Table 3.9-2) will not be discussed further.

3.9.3.2.1.1 No Action Alternative

Training Activities

There are no training activities under the No Action Alternative that would involve electromagnetic activities.

Testing Activities

There are no testing activities under the No Action Alternative that would involve electromagnetic activities.

3.9.3.2.1.2 Alternative 1

Training Activities

As indicated in Section 3.0.5.3.2.1 (Electromagnetic Devices), training activities involving electromagnetic devices under Alternative 1 occur up to five times annually as part of mine countermeasure (MCM) (towed mine detection) and Civilian Port Defense activities. Table 2.8-1 lists the number and location of training activities that use electromagnetic devices. Exposure of fishes to electromagnetic stressors is limited to those fish (primarily elasmobranchs, tuna, and eels) that are able to detect the electromagnetic properties in the water column (Bullock et al. 1983; Helfman et al. 2009b).

Electromagnetic devices are used primarily during mine detection/neutralization activities, and in most cases, the devices simply mimic the electromagnetic signature of a vessel passing through the water. None of the devices include any type of electromagnetic "pulse." The towed body used for mine sweeping is designed to simulate a ship's electromagnetic signal in the water, and so would not be experienced by fishes as anything unusual. The static magnetic field generated by the electromagnetic systems is of relatively minute strength, typically 23 gauss at the cable surface and 0.002 gauss at a radius of 656 ft. (199.9 m). The strength of the electromagnetic field decreases quickly away from the cable down to the level of earth's magnetic field (0.5 gauss) at less than 13 ft. (3.9 m) from the source (Department of Navy 2005a). In addition, training activities generally occur offshore in the water column, where fishes with high mobility predominate and fish densities are relatively low, compared with nearshore benthic habitat. Because the towed body is continuously moving, most fishes are expected to move away from it or follow behind it, in ways similar to responses to a vessel.

For any electromagnetically sensitive fishes in close proximity to the source, the generation of electromagnetic fields during training activities has the potential to interfere with prey detection and navigation. They may also experience temporary disturbance of normal sensory perception or could experience avoidance reactions (Kalmijn 2000), resulting in alterations of behavior and avoidance of normal foraging areas or migration routes. Mortality from electromagnetic devices is not expected.

Therefore, the electromagnetic devices used would not cause any potential risk to fishes because (1) the range of impact (i.e., greater than earth's magnetic field) is small (i.e., 13 ft. [3.9 m] from the source), (2) the electromagnetic components of these activities are limited to simulating the electromagnetic signature of a vessel as it passes through the water, and (3) the electromagnetic signal is temporally variable and would cover only a small spatial range during each activity in the Study Area. Some fishes could have a detectable response to electromagnetic exposure, but any impacts would be temporary with no anticipated impact on an individual's growth, survival, annual reproductive success, or lifetime reproductive success (i.e., fitness). Fitness refers to changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success. Electromagnetic exposure of eggs and larvae of sensitive bony fishes would be low relative to their total ichthyoplankton biomass (Able and Fahay 1998) and; therefore, potential impacts on recruitment would not be expected.

Testing Activities

As described in Section 2.7 (Alternative 1 [Preferred Alternative]: Expansion of Study Area Plus Adjustments to the Baseline and Additional Weapons, Platforms, and Systems), Alternative 1 consists of the No Action Alternative and adjustments to location, type, and tempo of training and testing activities, which includes the addition of platforms and systems.

Mine Countermeasure Mission package testing for new ship systems includes the use of electromagnetic devices (magnetic fields generated underwater to detect mines). Under Alternative 1, the Naval Sea Systems Command will engage in up to 32 MCM mission package testing activities annually. Exposure of fishes to electromagnetic stressors is limited to those fish groups identified in Sections 3.9.2.3 to 3.9.2.21 (Marine Fish Groups) that are able to detect the electromagnetic properties in the water column (Bullock et al. 1983; Helfman et al. 2009b). Fish species that do not occur within these specified areas would not be exposed to the electromagnetic fields. The electromagnetic devices used in testing activities would not cause any potential risk to fishes for the same reasons stated for training activities above.

3.9.3.2.1.3 Alternative 2

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1. Therefore, the impacts from electromagnetic training events under Alternative 2 would be the same as those described under Alternative 1.

Testing Activities

Mine Countermeasure Mission package testing for new ship systems includes the use of electromagnetic devices (magnetic fields generated underwater to detect mines). Under Alternative 2, the Naval Sea Systems Command will engage in up to 36 Mine Counter Measure mission package testing activities annually. Exposure of fishes to electromagnetic stressors is limited to those fish groups identified in Sections 3.9.2.3 to 3.9.2.21 (Marine Fish Groups) that are able to detect the electromagnetic properties in the water column (Bullock et al. 1983; Helfman et al. 2009b). Fish species that do not occur within these specified areas would not be exposed to the electromagnetic fields. The electromagnetic devices used in testing activities would not cause any potential risk to fishes for the same reasons stated for training activities above.

3.9.3.2.2 Summary and Conclusions of Energy Impacts

Under the No Action Alternative, Alternative 1, or Alternative 2, disturbance from activities using electromagnetic energy could be expected to elicit brief behavioral or physiological responses only in those exposed fishes with sensitivities/detection abilities (primarily sharks and rays) within the corresponding portion of the electromagnetic spectrum that these activities use. For electromagnetic devices, the typical reaction would be for the fish to avoid (move away from) the signal upon detection. The impact of electromagnetic signals are expected to be inconsequential on fishes or fish populations because signals are similar to regular vessel traffic, and the electromagnetic signal would be continuously moving and cover only a small spatial area during use.

3.9.3.3 Physical Disturbance and Strike Stressors

This section evaluates the potential effects of various types of physical disturbance and strike stressors associated with Navy training and testing activities within the Study Area. Section 3.0.5.3.3 (Physical Disturbance and Strike Stressors) discusses the activities that may produce physical disturbance and strike stressors.

Physical disturbance and strike risks have the potential to impact all taxonomic groups found within the Study Area (Table 3.9-2), because strikes could occur anywhere in the water column or on the seafloor. Potential impacts of physical strike include behavioral responses such as avoidance response behavior, change in swimming speed/direction, physiological stress response, temporary disorientation, injury, or mortality. These disturbances could result in abnormal behavioral, growth, or reproductive impacts. Although fishes can detect approaching vessels using a combination of sensory abilities (sight, hearing, lateral line), the slow-moving fishes (e.g., ocean sunfish, basking sharks) are unable to avoid all collisions, with some vessel strikes resulting in mortality.

The way a physical strike impacts a fish would depend in part on the relative size of the object and the location of the fish in the water column. Before being struck by an object, the fish would sense a pressure wave through the water (Hawkins and Johnstone 1978). Small fishes in the open water, such as anchovies or sardines, would simply be displaced by the movement generated by a large object moving through the water. Some fish might have time to detect the approaching object and swim away; others could be struck before it becomes aware of the object. An open-ocean fish displaced a small distance by movements from an object falling into the water nearby would likely continue on as if nothing had happened. However, a bottom-dwelling fish in the vicinity of a falling object would likely be disturbed and may exhibit a generalized stress response. If the object actually hit the fish, direct injury in addition to stress may result. As in all vertebrates, the function of the stress response in fishes is to rapidly raise the blood sugar level to prepare the fish to flee or fight (Helfman et al. 2009). This generally adaptive physiological response can become a liability to the fish if the stressor persists and the fish is not able to return to its baseline physiological state. When stressors are chronic, the fish may experience reduced growth, health, or survival (Wedemeyer et al. 1990).

Most fishes respond to sudden physical approach or contact by darting quickly away from the stimulus. Other species may respond by freezing in place and adopting cryptic coloration. In either case, the individual must stop its current activity and divert its physiological and cognitive attention to responding to the stressor (Helfman et al. 2009). The energy costs of reacting to a stressor depend on the specific situation, but in all cases the caloric requirements of stress reactions reduce the amount of energy available to the fish for other functions, such as predator avoidance, reproduction, growth, and maintenance (Wedemeyer et al. 1990).

The ability of a fish to return to its previous activity following a physical strike (or near-miss resulting in a stress response) is a function of both genetic and environmental factors. Some fish species are more tolerant of stressors than others and become acclimated more easily. Experiments with species for use in aquaculture have revealed the immense variability among species in their tolerance to crowding, handling, and other physical stressors, as well as to chemical stressors. Within a species, the rate at which an individual recovers from a physical strike may be influenced by its age, sex, reproductive state, and general condition. A fish that has reacted to a sudden disturbance by swimming at burst speed would tire after only a few minutes; its blood hormone and sugar levels (cortisol and glucose) may not return to normal for 24 hours. During the recovery period, the fish would not be able to attain burst speeds and would be more vulnerable to predators (Wardle 1986). If the individual were not able to regain a steady state following exposure to a physical stressor, it may suffer reduced immune function and even death (Wedemeyer et al. 1990).

Potential impacts of physical disturbance or strike to adults may be different than for other lifestages (eggs, larvae, juveniles) because these lifestages do not necessarily occur together in the same location (Botsford et al. 2009; Sabates et al. 2007), and many egg and larval stages occur near the water surface. Early lifestages of most fishes could be displaced by vessels, but not struck in the same manner as adults of larger species. Early lifestages could also become entrained by the propeller movement, or propeller wash, of vessels. However, no measurable impacts on fish recruitment would occur because the number of eggs and larvae exposed to vessel movements would be low relative to total ichthyoplankton biomass.

3.9.3.3.1 Impacts from Vessel and In-Water Devices

The majority of the activities under all 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 Chapter 2 and Section 3.0.5.3.3 (Physical Disturbance and Strike Stressors).

Vessels and in-water devices do not normally collide with adult fish, most of which can detect and avoid them. One study on fishes' behavioral responses to vessels showed that most adults exhibit avoidance responses to engine noise, sonar, depth finders, and fish finders (Jørgensen et al. 2004), reducing the potential for vessel strikes. Misund (1997) found that fishes ahead of a ship that showed avoidance reactions did so at ranges of 160 to 490 ft. (48.8 to 149.4 m). When the vessel passed over them, some fishes responded with sudden escape responses that included lateral avoidance or downward compression of the school. Conversely, Rostad et al. (2006) observed that some fishes are attracted to different types of vessels (e.g., research vessels, commercial vessels) of varying sizes, noise levels, and habitat locations. Fish behavior in the vicinity of a vessel is therefore quite variable, depending on the type of fish, its life history stage, behavior, time of day, and the sound propagation characteristics of the water (Schwarz 1985). Early life stages of most fishes could be displaced by vessels and not struck in the same manner as adults of larger species. However, a vessel's propeller movement or propeller wash could entrain early life stages. The low-frequency sounds of large vessels or accelerating small vessels caused avoidance responses among herring (Chapman and Hawkins 1973), but avoidance ended within 10 seconds after the vessel departed. Because a towed in-water device is continuously moving, most fishes are expected to move away from it or to follow behind it, in a manner similar to their responses to a vessel. When the device is removed, most fishes would simply move to another area.

There are a few notable exceptions to this assessment of potential vessel strike impacts on marine fish groups. Large slow-moving fish such as ocean sunfish, whale sharks, basking sharks, and manta rays occur near the surface in open-ocean and coastal areas, and are more susceptible to ship strikes, causing blunt trauma, lacerations, fin damage, or mortality. Speed et al. (2008) evaluated this specifically for whale sharks, but these other large slow-moving fishes are also likely to be susceptible because of their similar behavior and location in the water column. Increases in the numbers and sizes of shipping vessels in the modern cargo fleets make it difficult to gather mortality data because personnel on large ships are often unaware of whale shark collisions (Stevens 2007), therefore, the occurrence of whale shark strikes is likely much higher than has been documented by the few studies that have been conducted. The results of a whale shark study outside of the Study Area in the Gulf of Tadjoura, Djibouti, revealed that of the 23 whale sharks observed during a 5-day period, 65 percent had scarring from boat and propeller strikes (Rowat et al. 2007). Based on the typical physiological responses described in Section 3.9.3.3 (Physical Disturbance and Strike Stressors), vessel movements are not expected to compromise the general health or condition of individual fishes, except for whale sharks, basking sharks, manta rays, and ocean sunfish.

3.9.3.3.1.1 No Action Alternative, Alternative 1 and Alternative 2

Training Activities

As indicated in Sections 3.0.5.3.3 (Physical Disturbance and Strike Stressors) and 3.0.5.3.3.2 (In-Water Devices), training activities involving in-water devices can occur anywhere in the Study Area. Navy vessel activity primarily occurs within the U.S. Exclusive Economic Zone, and certain portions of the Study Area, such as areas near ports or naval installations and training ranges are used more heavily by vessels than other portions of the Study Area. These activities do not differ seasonally and could be widely dispersed throughout the Study Area. The differences in the number of in-water device activities between alternatives increases under Alternative 1 and Alternative 2 compared to the No Action Alternative; however, this increase is not expected to increase impacts. Species that do not occur near the surface within the Study Area would not be exposed to in-water device strike potential.

Exposure of fishes to vessel strike stressors is limited to those fish groups identified in Sections 3.9.2.3 to 3.9.2.21 (Marine Fish Groups) that are large, slow-moving, and may occur near the surface, such as ocean sunfish, whale sharks, and manta rays. These species are most likely distributed widely in offshore and nearshore portions of the Study Area. Any isolated cases of a Navy vessel striking an individual could injure that individual, impacting the fitness of an individual fish, but not to the extent that the viability of populations would be impacted. Vessel strikes would not pose a risk to most of the other marine fish groups, because many fish can detect and avoid vessel movements, making strikes rare and allowing the fish to return to their normal behavior after the ship or device passes. As a vessel approaches a fish, they could have a detectable behavioral or physiological response (e.g., swimming away and increased heart rate) as the passing vessel displaces them. However, such reactions are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of these marine fish groups at the population level.

Operational features of in-water devices and their use substantially limit the exposure of fish to potential strikes. First, in-water devices would not pose any strike risk to benthic fishes because the towed equipment is designed to stay off the bottom. Prior to deploying a towed in-water device, there is a standard operating procedure to search the intended path of the device for any floating debris (i.e., driftwood) or other potential obstructions, since they have the potential to cause damage to the device.

The likelihood of strikes by towed mine warfare devices on adult fish, which could result in injury or mortality, would be extremely low because these life stages are highly mobile. The use of in-water devices may result in short-term and local displacement of fishes in the water column. However, these behavioral reactions are not expected to result in substantial changes to an individual’s fitness, or species recruitment, and are not expected to result in population-level impacts. Ichthyoplankton (fish eggs and larvae) in the water column could be displaced, injured, or killed by towed mine warfare devices. The numbers of eggs and larvae exposed to vessels or in-water devices would be extremely low relative to total ichthyoplankton biomass (Able and Fahay 1998); therefore, measurable changes on fish recruitment would not occur.

The risk of a strike from vessels and in-water devices used in training activities would be extremely low because: (1) most fish can detect and avoid vessel and in-water device movements, and (2) the types of fish that are likely to be exposed to vessel and in-water device strike are limited and occur in low concentrations where vessels and in-water devices are used. Potential impacts of exposure to vessels and in-water devices are not expected to result in substantial changes to an individual’s behavior, fitness, or species recruitment, and are not expected to result in population-level impacts. Since impacts from strikes would be rare, and although any increase in vessel and in-water device use proposed under Alternatives 1 and 2 could potentially increase the probability of a strike, for the reasons stated above for the No Action Alternative, impacts on fish or fish populations would be negligible.

Testing Activities

As indicated in Sections 3.0.5.3.3 (Physical Disturbance and Strike Stressors) and 3.0.5.3.3.2 (In-Water Devices), testing activities involving in-water devices can occur anywhere in the Study Area.

As discussed for training activities, the risk of a strike from vessels and in-water devices used in testing activities would be extremely low because: (1) most fish can detect and avoid vessel and in-water device movements, and (2) the types of fish that are likely to be exposed to vessel and in-water device strike are limited and occur in low concentrations where vessels and in-water devices are used. Potential impacts of exposure to vessels and in-water devices are not expected to result in substantial changes to an individual’s behavior, fitness, or species recruitment, and are not expected to result in population-level impacts. Since impacts from strikes would be rare, and although any increase in vessel and in-water device use proposed under Alternatives 1 and 2 could potentially increase the probability of a strike, for the reasons stated above for the No Action Alternative, Alternative 1, and Alternative 2, impacts on fish or fish populations would be negligible.

3.9.3.3.2 Impacts from Military Expended Materials

Navy training and testing activities in the Study Area include firing a variety of weapons and employing a variety of explosive and non-explosive rounds including bombs, and small-, medium-, and large-caliber projectiles, or even entire ship hulks during a sinking exercise. During these training and testing activities, various items may be introduced and expended into the marine environment and are referred to as military expended materials.

This section analyzes the strike potential to marine fish of the following categories of military expended materials: (1) non-explosive practice munitions; (2) fragments from explosive munitions; and (3) expended materials other than ordnance, 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 3.0.5.3.3.4 (Military Expended Material).

While disturbance or strike from any of these objects as they sink through the water column is possible, it is not very likely for most expended materials because the objects generally sink through the water slowly and can be avoided by most fishes. Although some objects may sink faster, it is unlikely even at these faster rates that fish in the middle of the water column would be struck. Therefore, with the exception of sinking exercises, the discussion of military expended materials strikes focuses on strikes at the surface or in the upper water column from fragments (of explosives) and projectiles because those items have a greater potential for a fish strike as they hit the water, before slowing down as they move through the water column.

Vessel Hulk. During a sinking exercise, aircraft, ship, and submarine crews deliver ordnance on a seaborne target, usually a clean deactivated ship (Section 3.1, Sediments and Water Quality), which is deliberately sunk using multiple weapon systems. Sinking exercises occur in specific open ocean areas, outside of the coastal area, in waters exceeding 3,000 m (9,842.5 ft.) in depth, as shown in Figure 3.0-2. Direct ordnance strikes from the various weapons used in these exercises are a source of potential impact. However, these impacts are discussed for each of those weapons categories in this section and are not repeated here. Therefore, the analysis of sinking exercises as a strike potential for benthic fishes is discussed in terms of the ship hulk landing on the seafloor.

Small-, Medium-, and Large-Caliber Projectiles. Various types of projectiles could cause a temporary (seconds), localized impact when they strike the surface of the water. Current Navy training and testing in the Study Area, such as gunnery exercises, include firing a variety of weapons and using a variety of non-explosive training and testing rounds, including small-, medium-, and large-caliber projectiles. The larger-caliber projectiles are primarily used in the open ocean beyond 12 nm. Direct ordnance strikes from firing weapons are potential stressors to fishes. There is a remote possibility that an individual fish at or near the surface may be struck directly if it is at the point of impact at the time of non-explosive ordnance delivery. Expended rounds may strike the water surface with sufficient force to cause injury or mortality. There are 77 epipelagic species (including flying fish, jacks, and tuna) in the Study Area swim right at, or near, the surface of the water (Myers and Donaldson 2003).

Various projectiles will fall on soft or hard bottom habitats, where they could either become buried immediately in the sediments, or sit on the bottom for an extended time period (see Figures 3.3-1 through 3.3-5). Except for the 5 in. (12.7 cm) and the 30 mm rounds, which are fired from a helicopter, all projectiles will be aimed at surface targets. These targets will absorb most of the projectiles' energy before they strike the surface of the water and sink. This factor will limit the possibility of high-velocity impacts with fish from the rounds entering the water. Furthermore, fish can quickly and easily leave an area temporarily when vessels or helicopters approach. It is reasonable to assume, therefore, that fish will leave an area prior to, or just after the onset of, projectile firing and will return once tests are completed.

Most ordnance would sink through the water column and come to rest on the seafloor, stirring up sediment and possibly inducing a startle response, displacing, or injuring nearby fishes in extremely rare cases. Particular impacts on a given fish species would depend on the size and speed of the ordnance, the water depth, the number of rounds delivered, the frequency of training and testing, and the sensitivity of the fish.

Bombs, Missiles, and Rockets. Direct ordnance strikes from bombs, missiles, and rockets are potential stressors to fishes. Some individual fish at or near the surface may be struck directly if they are at the point of impact at the time of non-explosive ordnance delivery. However, most missiles hit their target or are disabled before hitting the water. Thus, most of these missiles and aerial targets hit the water as fragments, which quickly dissipates their kinetic energy within a short distance of the surface. A limited number of fishes swim right at, or near, the surface of the water, as described for small-, medium-, and large-caliber projectiles.

Statistical modeling could not be conducted to estimate the probability of military expended material strikes on fish, because fish density data are not available at the scale of an Operating Area or testing range. In lieu of strike probability modeling, the number, size, and area of potential impact (or "footprints") of each type of military expended material is presented in Tables 3.3-4 through 3.3-6. The application of this type of footprint analysis to fish follows the notion that a fish occupying the impact area could be susceptible to potential impacts, either at the water surface (e.g., pelagic sharks, flying fishes, jacks, tuna, mackerels, billfishes, and molas [Table 3.9-2]) or as military expended material falls through the water column and settles to the bottom (e.g., flounders, skates, and other benthic fishes listed in Table 3.9-2). Furthermore, 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. Of that small portion, a small number of fish at or near the surface (pelagic fishes) or near the bottom (benthic fishes) may be directly impacted if they are in the target area and near the expended item that hits the water surface (or bottom), but population-level effects would not occur.

Propelled fragments are produced by an exploding bomb. Close to the explosion, fishes could potentially sustain injury or death from propelled fragments (Stuhmiller et al. 1990). However, studies of underwater bomb blasts have shown that fragments are larger than those produced during air blasts and decelerate much more rapidly (O'Keefe and Young 1984; Swisdak Jr. and Montaro 1992), reducing the risk to marine organisms.

Fish disturbance or strike could result from bomb fragments (after explosion) falling through the water column in very small areas compared to the vast expanse of the testing ranges, operating areas, range complexes, or the Study Area. The expected reaction of fishes exposed to this stressor would be to immediately leave the area where bombing is occurring, thereby reducing the probability of a fish strike after the initial expended materials hit the water surface. When a disturbance of this type concludes, the area would be repopulated and the fish stock would rebound with inconsequential impacts on the resource (Lundquist et al. 2010).

3.9.3.3.2.1 No Action Alternative

<u>Training Activities</u>

Marine fish groups identified in Sections 3.9.2.3 to 3.9.2.21 (Marine Fish Groups) that are particularly susceptible to military expended material strikes are those occurring at the surface, within the offshore and coastal portions of the range complexes (where the strike would occur). Those groups include pelagic sharks, flying fishes, jacks, tuna, mackerels, billfishes, molas, and other similar species (see Table 3.9-2). Additionally, certain deep-sea fishes would be exposed to strike risk as a ship hulk, expended during a sinking exercise, settles to the seafloor. These groups include hagfishes, lanternfishes, and anglerfishes.

An estimated 116,271 military expended materials would be used annually during training activities within the MITT Study Area (Tables 3.0-18 through 3.0-20 and 3.0-25 through 3.0-27). Projectiles, bombs, missiles, rockets, torpedoes and associated fragments have the potential to directly strike fish as they hit the water surface and below the surface to the point where the projectile loses its forward momentum. Fish at and just below the surface would be most susceptible to injury from strikes because velocity of these materials would rapidly decrease upon contact with the water and as the materials travel through the water column. Consequently, most water column fishes would have ample time to detect and avoid approaching munitions or fragments as they fall through the water column. The probability of strike based on the "footprint" analysis included in Table 3.3-4 indicates that even for an extreme case of expending all small-caliber projectiles within a single gunnery box, the probability of any of these items striking a fish (even as large as bluefin tuna or whale sharks) is extremely low. Therefore, since most fishes are smaller than bluefin tuna or whale sharks, and most military expended materials are less abundant than small-caliber projectiles, the risk of strike by these items is exceedingly low for fish overall. A possibility exists that a small number of fish at or near the surface may be directly impacted if they are in the target area and near the point of physical impact at the time of military expended material strike, but population-level impacts would not occur.

Sinking exercises occur in open-ocean areas, outside of the coastal waters. While serious injury or mortality to individual fish would be expected if they were present in the immediate vicinity of the high intensity of explosive stressors (analyzed in Section 3.9.3.1, Acoustic Stressors), sinking exercises under the No Action Alternative would not result in impacts on pelagic fish populations at the surface based on the low number of fish in the immediate area and the placement of these activities in deep, ocean areas where fish abundance is low or widely dispersed. Disturbances to benthic fishes from sinking exercises would be highly localized. Any deep sea fishes located on the bottom where a ship hulk would settle could experience displacement, injury, or death. However, population level impacts on the deep sea fish community would not occur because of the limited spatial extent of the impact.

The impact of military expended material strikes would be inconsequential due to (1) the limited number of species found directly at the surface where military expended material strikes could occur, (2) the rare chance that a fish might be directly struck at the surface by military expended materials, and (3) the ability of most fish to detect and avoid an object falling through the water below the surface. The potential impacts of military expended material strikes would be short-term (seconds) and localized disturbances of the water surface (and seafloor areas within sinking exercise boxes), and are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction at the population level.

Testing Activities

No military expended materials will be used during testing activities under the No Action Alternative (Tables 3.0-18 through 3.0-20 and 3.0-25 through 3.0-27).

3.9.3.3.2.2 Alternative 1

Training Activities

An estimated 261,482 military expended materials would be used annually during training activities (Tables 3.0-18 through 3.0-20 and 3.0-25 through 3.0-27), which is a 120 percent increase over the No Action Alternative. Compared to the No Action Alternative, the overall increase in military expended materials used under Alternative 1 is due primarily to a large increase in medium-caliber projectiles, and a relatively smaller increase in the number of small-caliber projectiles. These changes would result in increased exposure of fish to military expended materials; however, for reasons stated in the No Action Alternative, the overall increase of military expended material under Alternative 1 would not result in an increased strike risk. The impact of military expended material strikes would be inconsequential due to (1) the limited number of species found directly at the surface where military expended material strikes could occur, (2) the rare chance that a fish might be directly struck at the surface by military expended materials, and (3) the ability of most fish to detect and avoid an object falling through the water below the surface. The potential impacts of military expended material strikes would be short-term (seconds) and localized disturbances of the water surface and seafloor areas, and are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction at the population level.

Testing Activities

An estimated 23,713 military expended materials would be used annually during testing activities under Alternative 1 (Tables 3.0-18 through 3.0-20 and 3.0-25 through 3.0-27). These expended materials would result in increased exposure of fish to potential strikes; however, for reasons stated in the No Action Alternative for training, the overall increase of military expended material under Alternative 1 would result in an increased strike risk; however, this increase would be negligible. The impact of military expended material strikes would be inconsequential due to (1) the limited number of species found directly at the surface where military expended material strikes could occur, (2) the rare chance that a fish might be directly struck at the surface by military expended materials, and (3) the ability of most fish to detect and avoid an object falling through the water below the surface. The potential impacts of military expended material strikes would be short-term (seconds) and localized disturbances of the water surface and seafloor areas, and are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction at the population level.

3.9.3.3.2.3 Alternative 2

Training Activities

An estimated 269,375 military expended materials would be used annually during training activities under Alternative 2 (Tables 3.0-18 through 3.0-20 and 3.0-25 through 3.0-27), which is a 130 percent increase over the No Action Alternative. Compared to the No Action Alternative, the overall increase in military expended materials used under Alternative 2 is due primarily to a large increase in medium-caliber projectiles, and a relatively smaller increase in the number of small-caliber projectiles. These changes would result in increased exposure of fish to military expended materials; however, for reasons stated in the No Action Alternative and Alternative 1, the overall increase of military expended material under Alternative 2 would not result in an increased strike risk. The impact of military expended material strikes would be inconsequential due to (1) the limited number of species found directly at the surface where military expended material strikes could occur, (2) the rare chance that a fish might be directly struck at the surface by military expended materials, and (3) the ability of most fish to detect and avoid an object falling through the water below the surface. The potential impacts of military expended material strikes would be short-term (seconds) and localized disturbances of the water surface (and seafloor areas, and are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction at the population level.

Testing Activities

An estimated 27,415 military expended materials would be used annually during testing activities under Alternative 2 (Tables 3.0-18 through 3.0-20 and 3.0-25 through 3.0-27). These expended materials would result in increased exposure of fish to potential strikes; however, for reasons stated in Alternative 1, the overall increase of military expended material under Alternative 2 would result in an increased strike risk, although this risk would be minimal. The impact of military expended material strikes would be inconsequential due to (1) the limited number of species found directly at the surface where military expended material strikes could occur, (2) the rare chance that a fish might be directly struck at the surface by military expended materials, and (3) the ability of most fish to detect and avoid an object falling through the water below the surface. The potential impacts of military expended material strikes would be short-term (seconds) and localized disturbances of the water surface and seafloor areas, and are not expected to yield any behavioral changes or lasting effects on the survival, growth, recruitment, or reproduction at the population level.

3.9.3.3.3 Impacts from Seafloor Devices

For a discussion of the types of activities that use seafloor devices, where they are used, and how many activities would occur under each alternative, see Section 3.0.5.3.3.5 (Seafloor Devices). Seafloor devices include items that are placed on, dropped on, or moved along the seafloor such as mine shapes, anchor blocks, anchors, bottom-placed instruments, bottom-crawling unmanned undersea vehicles, and bottom-placed targets that are not expended. As discussed in the military expended materials strike section, objects falling through the water column will slow in velocity as they sink toward the bottom and could be avoided by most fish.

Seafloor devices with a strike potential for fish include those items temporarily deployed on the seafloor. The potential strike impacts of unmanned underwater vehicles, including bottom crawling types, are also included here. Some fishes are attracted to virtually any tethered object in the water column (Dempster and Taquet 2004) and could be attracted to an inert mine assembly. However, while a fish might be attracted to the object, their sensory abilities allow them to avoid colliding with fixed tethered objects in the water column (Bleckmann and Zelick 2009), so the likelihood of a fish striking one of these objects is implausible. Therefore, strike hazards associated with collision into other seafloor devices such as deployed mine shapes or anchored devices are highly unlikely to pose any strike hazard to fishes and are not discussed further.

3.9.3.3.3.1 No Action Alternative

Training Activities

Under the No Action Alternative, 480 mine shapes would be used during mine-laying training activities. Seafloor devices have the potential to directly strike fish as they hit the water surface and below the surface to the point where the device strikes the bottom. Fish at and just below the surface, as well as those on the bottom, would be most susceptible to injury from strikes because velocity of these materials would rapidly decrease upon contact with the water and as the materials travel through the water column. Consequently, most water column fishes would have ample time to detect and avoid approaching devices as they fall through the water column. A possibility exists that a small number of fish at or near the surface or resting on the bottom may be directly impacted if they are in the target area and near the point of physical impact at the time of seafloor device strike. However, the likelihood of one of these objects striking a fish is implausible, and in the rare event that a strike occurred, population-level impacts would not occur.

Testing Activities

Under the No Action Alternative, seafloor devices are only utilized during testing activities at the North Pacific Acoustic Lab's Deep Water site. The deep water experimental site consists of an acoustic tomography array, a distributed vertical line array, and moorings in the deep-water environment (depths greater than 3,280 ft. [1,000 m]) of the northwestern Philippine Sea. A possibility exists that a small number of fish at or near the surface may be directly impacted if they are in the target area and near the point of physical impact at the time of seafloor device strike, but the likelihood of one of these objects striking a fish is implausible and in the rare event that a strike occurred, population-level impacts would not occur.

3.9.3.3.3.2 Alternative 1

Training Activities

Under Alternative 1, 480 mine shapes would be used during mine-laying training activities. Mine shapes would be used in the designated mine neutralization sites. Additionally there would be 18 precision anchoring activities which would occur within predetermined shallow water anchorage locations near ports. Seafloor devices have the potential to directly strike fish as they hit the water surface and below the surface to the point where the device strikes the bottom. Fish at and just below the surface, as well as those on the bottom, would be most susceptible to injury from strikes because velocity of these materials would rapidly decrease upon contact with the water and as the materials travel through the water column. Consequently, most water column fishes would have ample time to detect and avoid approaching devices as they fall through the water column. A possibility exists that a small number of fish at or near the surface or resting on the bottom may be directly impacted if they are in the target area and near the point of physical impact at the time of seafloor device strike. However, the likelihood of one of these objects striking a fish is implausible, and in the rare event that a strike occurred, population-level impacts would not occur.

Testing Activities

Under Alternative 1, seafloor devices are utilized during pierside integrated swimmer defense activities, testing activities at the North Pacific Acoustic Lab's Deep Water site, and during the MCM mission package testing. The deep water experimental site consists of an acoustic tomography array, a distributed vertical line array, and moorings in the deep-water environment (depths greater than 3,280 ft. [1,000 m]) of the northwestern Philippine Sea.

Seafloor devices have the potential to directly strike fish as they hit the water surface and below the surface to the point where the device strikes the bottom. Fish at and just below the surface, as well as those on the bottom, would be most susceptible to injury from strikes because velocity of these materials would rapidly decrease upon contact with the water and as it the materials travel through the water column. Consequently, most water column fishes would have ample time to detect and avoid approaching devices as they fall through the water column. A possibility exists that a small number of fish at or near the surface or resting on the bottom may be directly impacted if they are in the target area and near the point of physical impact at the time of seafloor device strike. During the pierside integrated swimmer defense activities, seafloor devices are placed by hand on the seafloor and removed after the activity; therefore, there would be no impact to fish from these items. However, the likelihood of objects used during MCM mission package testing striking a fish is implausible, and in the rare event that a strike occurred, population-level impacts would not occur.

3.9.3.3.3.3 Alternative 2

Training Activities

Under Alternative 2, 480 mine shapes would be used during mine laying training activities. Mine shapes would be used in the designated mine neutralization sites. Additionally there would be 18 precision anchoring activities which would occur within predetermined shallow water anchorage locations near ports. Seafloor devices have the potential to directly strike fish as they hit the water surface and below the surface to the point where the device strikes the bottom. Fish at and just below the surface, as well as those on the bottom, would be most susceptible to injury from strikes because velocity of these materials would rapidly decrease upon contact with the water and as it the materials travel through the water column. Consequently, most water column fishes would have ample time to detect and avoid approaching devices as they fall through the water column. A possibility exists that a small number of fish at or near the surface or resting on the bottom may be directly impacted if they are in the target area and near the point of physical impact at the time of seafloor device strike. However, the likelihood of one of these objects striking a fish is implausible, and in the rare event that a strike occurred, population-level impacts would not occur.

Testing Activities

Under Alternative 2, seafloor devices are utilized during pierside integrated swimmer defense activities, testing activities at the North Pacific Acoustic Lab's Deep Water site, and during the MCM mission package testing. The deep water experimental site consists of an acoustic tomography array, a distributed vertical line array, and moorings in the deep-water environment (depths greater than 3,280 ft. [1,000 m]) of the northwestern Philippine Sea.

Seafloor devices have the potential to directly strike fish as they hit the water surface and below the surface to the point where the device strikes the bottom. Fish at and just below the surface, as well as those on the bottom, would be most susceptible to injury from strikes because velocity of these materials would rapidly decrease upon contact with the water and as it the materials travel through the water column. Consequently, most water column fishes would have ample time to detect and avoid approaching devices as they fall through the water column. A possibility exists that a small number of fish at or near the surface or resting on the bottom may be directly impacted if they are in the target area and near the point of physical impact at the time of seafloor device strike During the pierside integrated swimmer defense activities, seafloor devices are placed by hand on the seafloor and removed after the activity; therefore, there would be no impact to fish from these items. However, the likelihood of objects used during MCM mission package testing striking a fish is implausible, and in the rare event that a strike occurred, population-level impacts would not occur.

3.9.3.3.4 Summary and Conclusions of Physical Disturbance and Strike Impacts

The greatest potential for combined impacts of physical disturbance and strike stressors under the Proposed Action would occur for sinking exercises because of multiple opportunities for potential strike by vessel, ordnance, or other military expended material. Under the Proposed Action, no more than two sinking exercises would occur per year. Sinking exercises were specifically chosen to evaluate impacts on military expended material strike because sinking exercises represent the activity with the greatest amount of military expended materials by weight. During each sinking exercise, approximately 725 objects would be expended, including large bombs, missiles, large projectiles, torpedoes, and one target vessel. Therefore, during each sinking exercise, approximately 105 objects per square kilometer would sink to the ocean floor. These items, combined with the mass and size of the ship hulk itself, are representative of an extreme case for military expended materials of all types striking benthic fishes. However, the overlap of these activities would only occur during a limited number of activities and only within the open ocean areas where the sinking exercises areas are located.

A less intensive example of potential impacts of combined strike stressors would be for cases where a fish could be displaced by a vessel in the water column during any number of activities utilizing bombs, missiles, rockets, or projectiles. As the vessel maneuvers during the exercise, any fishes displaced by that vessel movement could potentially be struck by munitions expended by that vessel during that same exercise. This would be more likely to occur in concentrated areas of this type of activity (e.g., a gunnery exercise inside a gunnery box). However, the likelihood of this occurring is probably quite low anywhere else, because most activities do not expend their munitions towards, or in proximity to, a training or testing vessel for safety reasons. While small-caliber projectiles are expended away from but often close to the vessel from which the projectiles are fired, this does not necessarily increase the risk of strike. During the initial displacement of the fish from vessel activity, or after the first several projectiles are fired, most fishes would disperse widely and the probability of strike may actually be reduced in most cases. Also, the combination of these stressors would cease immediately when the activity ends; therefore, combination is possible but not reasonably foreseeable.

3.9.3.3.4.1 Summary of Physical Disturbance and Strike Stressors and General Conclusions

Research suggests that only a limited number of marine fish species are susceptible to being struck by a vessel. Most fishes would not respond to vessel disturbance beyond a temporary displacement from their normal activity, which would be inconsequential and not detectable. The Navy identified and analyzed three physical disturbance or strike substressors that have potential to impact fishes: vessel and in-water device strikes, military expended material strikes, and seafloor device strikes. While the potential for vessel strikes on fish can occur anywhere vessels are operated, most fishes are highly mobile and capable of avoiding vessels, expended materials, or objects in the water column. For the larger slower-moving species (e.g., whale shark, manta ray, and molas) the potential for a vessel or military expended material strike increases, as discussed in the analysis. The potential for a seafloor device striking a fish is very low because the sensory capabilities of most fishes allow them to detect and avoid underwater objects.

3.9.3.4 Entanglement Stressors

This section evaluates potential entanglement impacts of various types of expended materials used by the Navy during training and testing activities within the Study Area. The likelihood of fish being affected by an entanglement stressor is a function of the physical properties, location, and buoyancy of the object and the behavior of the fish as described in Appendix H.5 (Conceptual Framework for Assessing Effects from Entanglement). Two types of military expended materials are considered here: (1) fiber optic cables and guidance wires, and (2) decelerators/parachutes.

Most entanglement observations involve abandoned or discarded nets, lines, and other materials that form loops or incorporate rings (Laist 1987; Derraik 2002; Macfadyen et al. 2009; Keller et al. 2010). A 25-year dataset assembled by the Ocean Conservancy reported that fishing line, rope, and fishing nets accounted for approximately 68 percent of fish entanglements, with the remainder due to encounters with various items such as bottles, cans, and plastic bags (Ocean Conservancy 2010). No occurrences involving military expended materials were documented.

Fish entanglement occurs most frequently at or just below the surface or in the water column where objects are suspended. A smaller number involve objects on the seafloor, particularly abandoned fishing gear designed to catch bottom fish or invertebrates (Ocean Conservancy 2010). More fish species are entangled in coastal waters and the continental shelf than elsewhere in the marine environment because of higher concentrations of human activity (e.g., fishing, sources of entangling debris), higher fish abundances, and greater species diversity (Helfman et al. 2009; Macfadyen et al. 2009). The consequences of entanglement range from temporary and inconsequential to major physiological stress or mortality.

The Navy uses some types of materials that could become entanglement stressors during training and testing activities in the Study Area. Possible expended materials from MITT activities that pose a risk of entanglement include sonobuoy components, torpedo guidance wires, torpedo flex hoses, cables, and decelerators/parachutes. Cables are used to moor vessels, mine shapes, and other objects to the bottom, and to connect to seafloor devices. Cables used in these scenarios are held taut, have insufficient slack to form loops, and are recovered after use; therefore, no potential for entanglement exists and activities using cables in this way are not discussed further. A flex hose is released when a torpedo is deployed to protect the guidance wire while near the launch vessel. Flex hoses are stiff, heavy, and would rapidly sink to the bottom on release. The flex hose is designed to remain free of loops, so no potential for entanglement exists and is not discussed further.

Oceanic fishes may encounter guidance wires and decelerators/parachutes, but nearshore fishes are extremely unlikely to encounter these materials because of where activities occur. Training and testing using heavyweight torpedoes do not take place in nearshore waters, so guidance wires would not be expended there, although decelerators/parachutes could be expended indirectly by drifting in from offshore areas. The discussion in this section focuses on the likelihood of overlap of these expended items with those fishes in the water column and benthic habitats that might be susceptible to becoming entangled in these items. This evaluation is based on the size, location, and buoyancy of the object and the behavior of the fishes.

3.9.3.4.1 Impacts from Fiber Optic Cables and Guidance Wires

Fiber optic cables and guidance wires are used during training and testing activities. A discussion of the types of activities, physical characteristics, location of use, and the number of items expended under each alternative is presented in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires).

Marine fish groups identified in Sections 3.9.2 (Affected Environment), that could be susceptible to entanglement in expended cables and wires are those with elongated snouts lined with tooth-like structures that easily snag on other similar marine debris, such as derelict fishing gear (Macfadyen et al. 2009). Some elasmobranchs (hammerhead sharks) and billfish occurring within the offshore and continental shelf portions of the range complexes (where the potential for entanglement would occur) could be susceptible to entanglement in cables and wires. Species occurring outside the specified areas within these range complexes would not be exposed to fiber optic cables or guidance wires.

Once a guidance wire is released, it is likely to sink immediately and remain on the seafloor. In some cases, the wire may snag on a hard structure near the bottom and remain partially or completely suspended. The types of fish that encounter any given wire would depend, in part, on its geographic location and vertical location in the water column. In any situation, the most likely mechanism for entanglement would involve fish swimming through loops in the wire that tighten around it; however, loops are unlikely to form in guidance wire (Environmental Sciences Group 2005).

Because of their physical characteristics, guidance wires and fiber optic cables pose a potential, though unlikely, entanglement risk to susceptible fish. Potential entanglement scenarios are based on fish behavior in abandoned monofilament, nylon, and polypropylene lines used in commercial nets. Such derelict fishing gear is abundant in the ocean (Macfadyen et al. 2009) and pose a greater hazard to fish than the very thin wire expended by the Navy. Fishing gear materials often have breaking strengths that can be up to orders of magnitude greater than that of guidance wire and fiber optic cables (Environmental Sciences Group 2005), and are far more prone to tangling, as discussed in Section 3.0.5.3.4.1 (Fiber Optic Cables and Guidance Wires). Fiber optic cables do not easily form loops, are brittle, and break easily if bent, so they pose a negligible entanglement risk. Additionally, the encounter rate and probability of impact from guidance wires and fiber optic cables are low, as few are expended.

3.9.3.4.1.1 No Action Alternative

<u>Training Activities</u>

As indicated in Table 2.8-1, under the No Action Alternative, torpedoes expending guidance wire would occur in throughout the Study Area during tracking exercises, all greater than 3 nm from the shore. Under the No Action Alternative there would be a total of 40 events that would expend wires per year during training activities (Table 2.8-1). Billfishes and other open ocean species susceptible to entanglement that occur where the torpedoes are used may encounter the expended guidance wires. However, given the low numbers used, the likelihood of encountering the expended guidance wires would be extremely low in those isolated areas. Some individual fish could be injured or killed if entangled by guidance wire, but most would simply be temporarily disturbed and would recover completely soon after exposure.

Testing Activities

Under the No Action Alternative, no activities that could generate entanglement stressors are conducted in the Study Area (see Tables 2.8-2 to 2.8-4).

3.9.3.4.1.2 Alternative 1

Training Activities

Under Alternative 1, the number of fiber optic cables and guidance wires used for training activities would increase by approximately 40 percent compared to the No Action Alternative (Tables 3.0-23 and 3.0-24). Billfishes and other open ocean species susceptible to entanglement that occur where the torpedoes are used may encounter the expended guidance wires and fiber optic cables. However, given the low numbers used, the likelihood of encountering the expended guidance wires and fiber optic cables would be extremely low in those isolated areas. Some individual fish could be injured or killed if entangled by guidance wire or fiber optic cable, but most would simply be temporarily disturbed and would recover completely soon after exposure.

Testing Activities

As indicated in Tables 2.8-2 through 2.8-4 and Table 3.0-24, under Alternative 1, the number of torpedo activities that expended guidance wire increases from that of the No Action Alternative from 0 to 20. Under Alternative 1, MCM Mission Package testing (Table 2.8-3) expends up to 48 fiber optic cables. Billfishes and other open ocean species susceptible to entanglement may encounter expended fiber optic cables and guidance wires, if these species are in the same location. However, given the low numbers used, the likelihood of encountering the expended fiber optic cables and guidance wires would be extremely low in those isolated areas. Some individual fish could be injured or killed if entangled by fiber optic cables and guidance wire, but most would simply be temporarily disturbed and would recover completely soon after exposure.

3.9.3.4.1.3 Alternative 2

Training Activities

Under Alternative 2, the number of fiber optic cables and guidance wires used for training activities would increase by approximately 40 percent compared to the No Action Alternative (Tables 3.0-23 and 3.0-24). Billfishes and other open ocean species susceptible to entanglement that occur where the torpedoes are used may encounter the expended guidance wires and fiber optic cables. However, given the low numbers used, the likelihood of encountering the expended guidance wires and fiber optic cables would be extremely low in those isolated areas. Some individual fish could be injured or killed if entangled by guidance wire or fiber optic cable, but most would simply be temporarily disturbed and would recover completely soon after exposure.

Testing Activities

As indicated in Tables 2.8-2 through 2.8-4 and Table 3.0-24, under Alternative 2, the number of torpedo activities that expended guidance wire increases from that of the No Action Alternative from 0 to 20. Under Alternative 1, MCM Mission Package testing (Table 2.8-3) expends up to 56 fiber optic cables. Risk of entanglement resulting from proposed testing activities would be low as described in training activities above.

3.9.3.4.2 Impacts from Decelerators/Parachutes

Decelerators/parachutes of varying sizes are used during training and testing activities. The types of activities that use decelerators/parachutes, physical characteristics and size of decelerators/parachutes, locations where decelerators/parachutes are used, and the number of parachute activities proposed under each alternative are presented in Section 3.0.5.3.4.2 (Decelerators/Parachutes).

Fish face many potential entanglement scenarios in abandoned monofilament, nylon, polypropylene line, and other derelict fishing gear in the nearshore and offshore marine habitats of the Study Area (Macfadyen et al. 2009; Ocean Conservancy 2010). Abandoned fishing gear is dangerous to fish because it is abundant, essentially invisible, strong, and easily tangled. In contrast, decelerators/parachutes are rare, highly visible, and not designed to capture fish.

Once a parachute has been released to the water, it poses a potential entanglement risk to fish. The Naval Ocean Systems Center identified the potential impacts of torpedo air launch accessories, including decelerators/parachutes, on fish (U.S. Department of the Navy 1996). Unlike other materials in which fish become entangled (such as gill nets and nylon fishing line), the parachute is relatively large and visible, reducing the chance that visually oriented fish would accidentally become entangled in it. No cases of fish entanglement have been reported for decelerators/parachutes (U.S. Department of the Navy 2001a; Ocean Conservancy 2010). Entanglement in a newly-expended decelerator/parachute while it is in the water column is unlikely because fish generally react to sound and motion at the surface with a behavioral reaction by swimming away from the source (see Section 3.9.3.3.2, Impacts from Military Expended Materials) and would detect the oncoming decelerator/parachute in time to avoid contact. While the decelerator/parachute is sinking, fish would have ample opportunity to swim away from the large moving object. Even if the decelerator/parachute landed directly on a fish, it would likely be able to swim away faster than the decelerator/parachute would sink because the resistance of the water would slow the parachute’s downward motion.

Once the decelerator/parachute is on the bottom, however, it is feasible that a fish could become entangled in the decelerator/parachute or its suspension lines while diving and feeding, especially in deeper waters where it is dark. If the decelerator/parachute dropped in an area of strong bottom currents, it could billow open and pose a short-term entanglement threat to large fish feeding on the bottom. Benthic fish with elongated spines could become caught on the decelerator/parachute or lines. Most sharks and other smooth-bodied fish are not expected to become entangled because their soft, streamlined bodies can more easily slip through potential snares. A fish with spines or protrusions (e.g., some sharks, billfish, or sawfish) on its body that swam into the decelerator/parachute or a loop in the lines, and then struggled, could become bound tightly enough to prevent escape. Although this scenario is possible based on the structure of the materials and the shape and behavior of fish, it is not considered a likely event.

Aerial-launched sonobuoys are deployed with a decelerator/parachute. The sonobuoy itself is not considered an entanglement hazard for upon deployment (Environmental Sciences Group 2005), but their components may pose an entanglement hazard once released into the ocean. Sonobuoys contain cords, electronic components, and plastic mesh that may entangle fish (Environmental Sciences Group 2005). Open-ocean filter feeding species, such as whale sharks, and manta rays could become entangled in these items, whereas smaller species such as flying fish could become entangled in the plastic mesh in the same manner as a small gillnet. The sonobuoy canister is similar in diameter to a coffee can, which is a known entanglement risk to the smalltooth sawfish; these fish have been found with a plastic pipe or coffee can encircling their snouts, which can interfere with their feeding (Seitz and Poulakis 2006). A smalltooth sawfish could get its snout lodged inside a sonobuoy canister in this same manner. Since most sonobuoys are expended in offshore areas, many coastal fish would not encounter or have any opportunity to become entangled in materials associated with sonobuoys, apart from the risk of entanglement in decelerators/parachutes described above.

3.9.3.4.2.1 No Action Alternative

Training Activities

Under the No Action Alternative, approximately 8,032 decelerators/parachutes would be expended during training activities (see Table 3.0-25). Decelerators/parachutes would be expended in locations greater than 3 nm from shore throughout the Study Area.

Given the size of the range complex and the resulting widely scattered decelerators/parachutes, it would be very unlikely that fishes would encounter and become entangled in any decelerators/parachutes or sonobuoy accessories. If a few individual fish were to encounter and become entangled in any of these items, the growth, survival, annual reproductive success, or lifetime reproductive success of the population as a whole would not be impacted directly or indirectly.

Testing Activities

Under the No Action Alternative, no activities that would create entanglement hazards from decelerators/parachutes are conducted in the Study Area (see Table 3.0-25).

3.9.3.4.2.2 Alternative 1

As described in Section 2.7 (Alternative 1 [Preferred Alternative]: Expansion of Study Area Plus Adjustments to the Baseline and Additional Weapons, Platforms, and Systems), Alternative 1 consists of the No Action Alternative and adjustments to location, type, and tempo of training and testing activities, which includes the addition of platforms and systems.

Training Activities

Under Alternative 1, there would be 10,845 decelerators/parachutes expended during training activities, an increase by 35 percent from the number expended under the No Action Alternative (see Table 3.0-25).

Given the size of the range complexes and the resulting widely scattered decelerators/parachutes, it would be very unlikely that fishes would encounter and become entangled in any decelerators/parachutes or sonobuoy accessories. If a few individual fish were to encounter and become entangled in any of these items, the growth, survival, annual reproductive success, or lifetime reproductive success of the population as a whole would not be impacted directly or indirectly.

Testing Activities

Under Alternative 1, there would be 1,727 decelerators/parachutes expended during testing activities, an increase from the No Action Alternative (see Table 3.0-25).

Given the size of the MITT Study Area and the resulting widely scattered decelerators/parachutes, it would be very unlikely that fishes would encounter and become entangled in any decelerators/parachutes or sonobuoy accessories. If a fish were to encounter and become entangled in any of these items, the growth, survival, annual reproductive success, or lifetime reproductive success of populations would not be impacted directly or indirectly.

3.9.3.4.2.3 Alternative 2

Training Activities

The number and location of training activities under Alternative 2 are identical to training activities under Alternative 1 (see Table 3.0-25). Therefore, impacts and comparisons to the No Action Alternative will also be identical.

Testing Activities

Under Alternative 2, there would be 1,912 decelerators/parachutes expended during testing activities, an increase from the No Action Alternative (see Table 3.0-25).

Given the size of the MITT Study Area and the resulting widely scattered decelerators/parachutes, it would be very unlikely that fishes would encounter and become entangled in any decelerators/parachutes or sonobuoy accessories. If a few individual fish were to encounter and become entangled in any of these items, the growth, survival, annual reproductive success, or lifetime reproductive success of the populations as a whole would not be impacted directly or indirectly.

3.9.3.4.3 Summary and Conclusions of Entanglement Impacts

While most fish species are susceptible to entanglement in fishing gear that is designed to entangle a fish by trapping it by its gills or spines (e.g., gill nets), only a limited number of fish species that possess certain features such as an irregular shaped or rigid rostrum (snout) (e.g., billfish) are susceptible to entanglement by military expended materials. A survey of marine debris entanglements found no fish entanglements in military expended materials in a 25-year dataset (Ocean Conservancy 2010).

3.9.3.4.3.1 Combined Entanglement Stressors

An individual fish could experience the following consequences of entanglement stressors: displacement, stress, avoidance response, behavioral changes, entanglement causing injury, and entanglement causing mortality. If entanglement results in mortality, it cannot act in combination because mortal injuries occur with the first instance. Therefore, there is no possibility for the occurrence of this consequence to increase if sub-stressors are combined.

Sub-lethal consequences may result in delayed mortality because they cause irrecoverable injury or alter the individual's ability to feed or detect and avoid predation. Sub-lethal effects resulting in mortality could be more likely if the events occurred in essentially the same location and occurred within the individual's recovery time from the first disturbance. This circumstance is only likely to arise during training activities that cause frequent and recurring entanglement stressors to essentially the same location (e.g., torpedoes expended at the same location as sonobuoys). In these specific circumstances the potential consequences to fishes from combinations of entanglement stressors may be greater than the sum of their individual consequences.

These specific circumstances that could multiply the consequences of entanglement stressors are highly unlikely to occur for two reasons. First, it is highly unlikely that torpedo guidance wires and sonobuoy decelerators/parachutes would impact essentially the same space because most of these sub-stressors are widely dispersed in time and space. Second, the risk of injury or mortality is extremely low for each sub-stressor independently; therefore, the combined impact of these sub-stressors does not increase the risk in a meaningful way. Furthermore, while it is conceivable that interaction between sub-stressors could magnify their combined risks, the necessary circumstances are highly unlikely to overlap.

Interaction between entanglement sub-stressors is likely to have neutral consequences for fishes. There is no potential for these entangling objects to combine in a way that would multiply their impact, as is the case with derelict (abandoned or discarded) fishing nets that commonly occur in the Study Area (Macfadyen et al. 2009) and entangle fish by design. Fish entangled in derelict nets attract scavengers and predators that may themselves become entangled in an ongoing cycle (Morgan and Chuenpagdee 2003). Guidance wires and decelerators/parachutes are used relatively infrequently over a wide area, and are mobile for only a short time. Therefore, unlike discarded fishing gear, it is extremely unlikely that guidance wires and decelerators/parachutes could interact.

3.9.3.4.3.2 Summary of Entanglement Stressors

The Navy identified and analyzed three military expended materials types that have potential to entangle fishes: guidance wires, fiber optic cables, and decelerators/parachutes. Other military expended materials types such as bomb or missile fragments do not have the physical characteristics to entangle fishes in the marine environment and were not analyzed. Even for fishes that might encounter and become entangled in an expended guidance wire, the breaking strength of that wire is low enough that the impact would be only temporary and not likely to cause harm to the individual.

3.9.3.5 Ingestion Stressors

This section evaluates 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 Appendix H.6 (Conceptual Framework for Assessing Effects from Ingestion). Ingestion of expended materials by fish could occur in all large marine ecosystems and open ocean areas and can occur at or just below 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 fish. Floating material is more likely to be eaten by fish of all sizes that feed at or near the water surface (e.g., molas, whale sharks, manta rays, herring, or flying fish), while materials that sink to the seafloor present a higher risk to bottom-feeding fish (e.g., hammerhead sharks, skates, rays, and flounders).

It is reasonable to assume that any item of a size that can be swallowed by a fish could be eaten at some time; this analysis focuses on ingestion of materials in two locations: (1) at the surface or water column, and (2) at the seafloor. Open-ocean predators and open-ocean planktivores are most likely to ingest materials in the water column. Coastal bottom-dwelling predators and estuarine bottom-dwelling predators could ingest materials from the seafloor.

The Navy expends the following types of materials during training and testing in the Study Area that could become ingestion stressors: non-explosive practice munitions (small- and medium-caliber), fragments from explosives, fragments from targets, chaff, flare casings (including plastic end caps and pistons), and small decelerators/parachutes. The activities that expend these items and their general distribution are detailed in Section 3.0.5.3.5 (Ingestion Stressors). Metal items eaten by marine fish are generally small (such as fishhooks, bottle caps, and metal springs), suggesting that small- and medium-caliber projectiles, pistons, or end caps (from chaff canisters or flares) are more likely to be ingested. Both physical and toxicological impacts could occur as a result of consuming metal or plastic materials. Items of concern are those of ingestible size that either drift at or just below the surface (or in the water column) for a time or sink immediately to the seafloor. The likelihood that expended items would cause a potential impact on a given fish species depends on the size and feeding habits of the fish and the rate at which the fish encounters the item and the composition of the item. In this analysis only small- and medium-caliber munitions (or small fragments from larger munitions), chaff, small decelerators/parachutes, and end caps and pistons from flares and chaff cartridges are considered to be of ingestible size for a fish.

The analysis of ingestion impacts on fish is structured around the following feeding strategies:

Feeding at or Just Below the Surface or Within the Water Column

- **Open-Ocean Predators.** Large, migratory, open-ocean fish, such as tuna, sharks, and billfish, feed on fast-swimming prey in the water column of the Study Area. These fish range widely in search of unevenly distributed food patches. Smaller military expended materials could be mistaken for prey items and ingested purposefully or incidentally as the fish is swimming (Table 3.9-5). Prey fish sometimes dive deeper to avoid an approaching predator (Pitcher 1986). A few of these predatory fish (e.g., tiger sharks) are known to ingest any type of marine debris that they can swallow, even automobile tires. Some marine fish, such as the dolphinfish (*Coryphaena hippurus*) (South Atlantic Fishery Management Council 2011) and tuna (Hoss and Settle 1990), have been known to eat plastic fragments, strings, nylon lines, ropes, or even small light bulbs.
- **Open-Ocean Planktivores.** Plankton-eating fish in the open-ocean portion of the Study Area include flyingfish, whale sharks, and manta rays. These fish feed by either filtering plankton from the water column or by selectively ingesting larger zooplankton. These planktivores could encounter and incidentally feed on smaller types of military expended materials (e.g., chaff, end caps, and pistons) at or just below the surface or in the water column (Table 3.9-5). While not a plankton eater, molas may also be capable of ingesting items at or just below the surface in the open ocean.

Military expended materials that could potentially impact these types of fish at or just below the surface or in the water column include those items that float or are suspended in the water column for some period of time (e.g., decelerators/parachutes and end caps and pistons from chaff cartridges or flares).

Fish Feeding at the Seafloor

- **Coastal Bottom-Dwelling Predators/Scavengers.** Large predatory fishes near the seafloor are represented by scorpion fishes, groupers, and jacks, which are typical seafloor predators in coastal and oceanic waters of the Study Area (Table 3.9-5). These species feed opportunistically on or near the bottom, taking fish and invertebrates from the water column and from the bottom. Bottom-dwelling fishes in the coastal waters (Table 3.9-5) may feed by seeking prey and by scavenging on dead fishes and invertebrates (e.g., skates, rays, flatfish).

Military expended materials that could be ingested by fish at the seafloor include items that sink (e.g., small-caliber projectiles and casings, fragments from explosive munitions).

Table 3.9-5: Summary of Ingestion Stressors on Fish Based on Location

Feeding Guild	Representative Species	Overall Potential for Impact
Open-ocean predators	Tuna, most shark species	These fish may eat floating or sinking expended materials, but the encounter rate would be extremely low. May result in individual injury or death but is not anticipated to have population-level effects.
Open-ocean plankton eaters (planktivores)	Sardines, whale shark	These fish may ingest floating expended materials incidentally as they feed in the water column, but the encounter rate would be extremely low. May result in individual injury or death but is not anticipated to have population-level effects.
Coastal bottom-dwelling predators	Skates, and rays	These fish may eat expended materials on the seafloor, but the encounter rate would be extremely low. May result in individual injury or death but is not anticipated to have population-level effects.
Coastal bottom-dwelling scavengers	Skates and rays, flounders	These fish could incidentally eat some expended materials while foraging, especially in muddy waters with limited visibility. However, encounter rate would be extremely low. May result in individual injury or death but is not anticipated to have population-level effects.

Potential impacts of ingestion on adults are different than for other life stages (larvae and juveniles) because early life stages are too small to ingest any military expended materials except for chaff, which has been shown to have no impact on fish (U.S. Air Force 1997; Spargo 1999; Arfsten et al. 2002). Therefore, no ingestion potential impacts on early life stages would occur, with the exception of later stage juveniles that are large enough to ingest military expended materials.

Within the context of fish location in the water column and feeding strategies, the analysis is divided into (1) munitions (small- and medium-caliber projectiles, and small fragments from larger munitions); and (2) military expended material other than munitions (chaff, chaff end caps, pistons, decelerators/parachutes, flares, and target fragments).

3.9.3.5.1 Impacts from Munitions and Military Expended Materials Other than Munitions

The potential impacts of ingesting foreign objects on a given fish depend on the species and size of the fish. Fish that normally eat spiny, hard-bodied invertebrates could be expected to have tougher mouths and digestive systems than fish that normally feed on softer prey. Materials that are similar to the normal diet of a fish would be more likely to be ingested and more easily handled once ingested—for example, by fish that feed on invertebrates with sharp appendages. These items could include fragments from explosives that a fish could encounter on the seafloor. Relatively small or smooth objects, such as small-caliber projectiles or their casings, might pass through the digestive tract without causing harm. A small sharp-edged item could cause a fish immediate physical distress by tearing or cutting the mouth, throat, or stomach. If the object is rigid and large (relative to the fish's mouth and throat), it may block the throat or obstruct the flow of waste through the digestive system. An object may be enclosed by a cyst in the gut lining (Hoss and Settle 1990; Danner et al. 2009). Ingestion of large foreign objects could lead to disruption of a fish's normal feeding behavior, which could be sublethal or lethal.

Munitions are heavy and would sink immediately to the seafloor, so exposure would be limited to those fish identified as bottom-dwelling predators and scavengers. It is possible that expended small-caliber projectiles on the seafloor could be colonized by seafloor organisms and mistaken for prey or that expended small-caliber projectiles could be accidentally or intentionally eaten during foraging. Over time, the metal may corrode or become covered by sediment in some habitats, reducing the likelihood of a fish encountering the small-caliber, non-explosive practice munitions.

Fish feeding on the seafloor in the offshore locations where these items are expended would be more likely to encounter and ingest them than fish in other locations. A particularly large item (relative to the fish ingesting it) could become permanently encapsulated by the stomach lining, with the rare chance that this could impede the fish's ability to feed or take in nutrients. However, in most cases, a fish would pass a round, smooth item through its digestive tract and expel it, with no long-term measurable reduction in the individual's fitness.

If explosive ordnance does not explode, it would sink to the bottom. In the unlikely event that explosive material, high-melting-point explosive (known as HMX) or royal demolition explosive (known as RDX), is exposed on the ocean floor it would break down in a few hours (U.S. Department of the Navy 2001a). HMX or RDX would not accumulate in the tissues of fish (Price et al. 1998; Lotufo et al. 2010). Fish may take up trinitrotoluene (TNT) from the water when it is present at high concentrations but not from sediments (Lotufo et al. 2010). The rapid dispersal and dilution of TNT expected in the marine water column reduces the likelihood of a fish encountering high concentrations of TNT to near zero. A study of discarded military munitions in Hawaii, at depths of 1,300–2,000 ft. (400–600 m), recorded no confirmed detections of chemical agents or explosives in the sediments or biota that could be attributed to the munitions (University of Hawaii at Manoa 2010).

3.9.3.5.1.1 No Action Alternative

<u>Training Activities</u>

Projectiles

Under the No Action Alternative, a total of 60,000 small-caliber projectiles would be expended during training activities). Under the No Action Alternative, a total of 61,786 munitions (other projectiles, bombs, and missiles of all sizes) would be expended during training activities.

These items are heavy and would sink immediately to the seafloor, so exposure to fishes would be limited to those groups identified as bottom-dwelling predators and scavengers. It is possible that expended small-caliber projectiles on the seafloor could be colonized by seafloor organisms and mistaken for prey or that expended small-caliber projectiles could be accidentally or intentionally eaten during foraging. Over time, the metal corrodes slowly or may become covered by sediment in some habitats, reducing the likelihood of a fish encountering the small-caliber non explosive practice munitions. Explosive munitions are typically fused to detonate within 5 ft. (1.5 m) of the water surface, with steel fragments breaking off in all directions and rapidly decelerating in the water and settling to the seafloor. The analysis generally assumes that most explosive expended materials sink to the seafloor and become incorporated into the seafloor, with no substantial accumulations in any particular area (see Section 3.1, Sediments and Water Quality).

Encounter rates in locations with concentrated small-caliber projectiles would be assumed to be greater than in less concentrated areas. Fishes feeding on the seafloor in the offshore locations where these items are expended (e.g., focused in gunnery boxes) would be more likely to encounter these items and at risk for potential ingestion impacts than in other locations. If ingested, and swallowed, these items could potentially disrupt an individual's feeding behavior or digestive processes. If the item is particularly large for the fish ingesting it, the projectile could become permanently encapsulated by the stomach lining, with the rare chance that this could impede the fish's ability to feed or take in nutrients. However, in most cases a fish would pass the round and smooth item through their digestive tract and expel the item with full recovery expected without impacting the individual's growth, survival, annual reproductive success, or lifetime reproductive success.

Unexploded explosive munitions would sink to the bottom. The residual explosive material would not be exposed to the marine environment, as it is encased in a non-buoyant cylindrical package. Should the High Melting point Explosive or Royal Demolition Explosive be exposed on the ocean floor, they would break down within a few hours (U.S. Department of the Navy 2001b) and would not accumulate in the tissues of fishes (Lotufo et al. 2010; Price et al. 1998). TNT would bioaccumulate in fish tissues if present at high concentrations in the water, but not from fish exposure to TNT in sediments (Lotufo et al. 2010). Given the rapid dispersal and dilution expected in the marine water column, the likelihood of a fish encountering high concentrations of TNT is very low. Over time, Royal Demolition Explosive residue would be covered by ocean sediments in most habitats or diluted by ocean water.

It is not possible to predict the size or shape of fragments resulting from explosives. Explosives used in the Study Area range in size from medium-caliber projectiles to large bombs, and missiles. When these items explode, they partially break apart or remain largely intact with irregular shaped pieces—some of which may be small enough for a fish to ingest. Fishes would not be expected to ingest most fragments from explosives because most pieces would be too large to ingest. Also, since fragment size cannot be quantified, it is assumed that fragments from larger munitions are similarly sized as larger munitions, but more fragments would result from larger munitions than smaller munitions. Small-caliber projectiles far outnumber the larger-caliber explosive projectiles/bombs/missiles/rockets expended as fragments in the Study Area. Although it is possible that the number of fragments resulting from an explosive could exceed this number, this cannot be quantified. Therefore, small-caliber projectiles would be more prevalent throughout the Study Area, and more likely to be encountered by bottom-dwelling fishes, and potentially ingested than fragments from any type of explosive munitions.

Sonobuoys

Under the No Action Alternative, approximately 8,073 sonobuoys would be expended during training activities. Small decelerators/parachutes associated with sonobuoys could be potentially ingested by open-ocean plankton eaters. Molas are the only fish species that could be susceptible to ingestion of sonobuoy decelerators/parachutes, because they are large enough to eat a parachute that they might mistake for jellyfish while foraging. The estimated density of sonobuoys in the Study Area is 0.013 sonobuoy per square nautical mile (nm^2) and, given this low density, it is not likely that an ocean sunfish would encounter any sonobuoy decelerators/parachutes; therefore, the risk of ingestion is extremely low for these fish.

Chaff and Flares

Under the No Action Alternative, a total of 5,830 chaff cartridges would be expended from aircraft during training activities. No potential impacts would occur from the chaff itself, as previously discussed, but there is some potential for the end caps or pistons associated with the chaff cartridges to be ingested. Under the No Action Alternative, a total of 5,740 flares would be expended during training flare exercises. The flare device consists of a cylindrical cartridge approximately 1.4 in. (3.6 cm) in diameter and 5.8 in. (14.7 cm) in length. Items that could be potentially ingested from flares include plastic end caps and pistons. An extensive literature review and controlled experiments conducted by the U.S. Air Force revealed that self-protection flare use poses little risk to the environment (U.S. Air Force 1997). The light generated by flares in the air (designed to burn out completely prior to entering the water) would have no impact on fish based on short burn time, relatively high altitudes where they are used, and the wide-spread and infrequent use. The potential exists for large, open-ocean predators (e.g., tunas, billfishes, pelagic sharks) to ingest self-protection flare end caps or pistons as they float on the water column for some time. A variety of plastic and other solid materials have been recovered from the stomachs of billfishes, dorado (South Atlantic Fishery Management Council 2011) and tuna (Hoss and Settle 1990).

End caps and pistons sink in saltwater (Spargo 2007), which reduces the likelihood of ingestion by surface-feeding fishes. However, some of the material could remain at or near the surface, and predatory fishes may incidentally ingest these items. Assuming that all end-caps and pistons would be evenly dispersed, the annual relative end-cap and piston concentration would be very low (0.02 nm^2).

Based on the low environmental concentration, it is unlikely that a larger number of fish would ingest an end cap or piston, much less a harmful quantity. Furthermore, a fish might expel the item before swallowing it. The number of fish potentially impacted by ingestion of end caps or pistons would be low based on the low environmental concentration and population-level impacts would not occur.

Summary of Training Activities

Overall, the potential impacts of ingesting small-caliber projectiles, explosive fragments, decelerators/parachutes, or end caps/pistons would be limited to individual cases where a fish might suffer a negative response, for example, ingesting an item too large to be digested. While ingestion of ordnance-related materials, or the other military expended materials identified here, could result in sublethal or lethal impacts, the likelihood of ingestion is low based on the dispersed nature of the materials and the limited exposure of those items at the surface/water column or seafloor where certain fishes could be at risk of ingesting those items. Furthermore, a fish might taste an item then expel it before swallowing it (Felix et al. 1995), in the same manner that fish would temporarily take a lure into its mouth, then spit it out. Based on these factors, the number of fish potentially impacted by ingestion of ordnance-related materials would be low and population-level impacts would not occur.

Testing Activities

Under the No Action Alternative, no military expended materials would be expended during testing activities.

3.9.3.5.1.2 Alternative 1

Training Activities

Projectiles

Under Alternative 1, a total of 86,140 small-caliber projectiles would be expended during training activities. Under Alternative 1, a total of 96,915 explosive munitions (projectiles, bombs, missiles, and rockets of all sizes) would be expended during training activities, a 57 percent increase over the No Action Alternative.

Sonobuoys

Under Alternative 1, a total of 10,980 sonobuoys would be expended during training activities, which would be a 37 percent increase over the No Action Alternative

Chaff and Flares

Under Alternative 1, a total of 25,840 chaff cartridges would be expended from aircraft during training activities, a 340 percent increase over the No Action Alternative. No potential impacts would occur from the chaff itself, as previously discussed, but there is some potential for the end caps or pistons associated with the chaff cartridges to be ingested.

Under Alternative 1, a total of 25,600 flares would be expended during training flare exercises, which would be a 340 percent increase over the No Action Alternative.

Summary of Training Activities

The increase in expended materials under Alternative 1 would increase the probability of ingestion risk; however, as discussed under the No Action Alternative, the likelihood of ingestion would still be low based on the dispersed nature of the materials and the limited exposure of those items at the surface/water column or seafloor where certain fishes could be at risk of ingesting those items. Therefore, the number of fish potentially impacted by ingestion of expended materials would be low and population-level impacts would not occur.

Testing Activities

Projectiles

Under Alternative 1, a total of 2,000 small-caliber projectiles would be expended during testing activities. Under Alternative 1, a total of 6,805 explosive munitions (projectiles, missiles, and torpedoes) would be expended during testing activities.

Sonobuoys

Under Alternative 1, a total of 2,006 sonobuoys would be expended during testing activities.

Chaff and Flares

Under Alternative 1, 600 chaff cartridges and 300 flares would be expended during testing exercises.

Summary of Testing Activities

The increase in expended materials under Alternative 1 would increase the probability of ingestion risk; however, the likelihood of ingestion would still be low based on the dispersed nature of the materials and the limited exposure of those items at the surface/water column or seafloor where certain fishes could be at risk of ingesting those items. Therefore, the number of fish potentially impacted by ingestion of expended materials would be low and population-level impacts would not occur.

3.9.3.5.1.3 Alternative 2

Training Activities

Projectiles

Under Alternative 2, a total of 86,140 small-caliber projectiles would be expended during training activities. Under Alternative 2, a total of 97,193 explosive munitions (projectiles, bombs, missiles, and rockets of all sizes) would be expended during training activities, a 57 percent increase over the No Action Alternative.

Sonobuoys

Under Alternative 2, a total of 10,991 sonobuoys would be expended during training, a 37 percent increase over the No Action Alternative.

Chaff and Flares

Under Alternative 2, a total of 28,512 chaff cartridges would be expended from aircraft during training activities, a 390 percent increase over the No Action Alternative. No potential impacts would occur from the chaff itself, as previously discussed, but there is some potential for the end caps or pistons associated with the chaff cartridges to be ingested.

Under Alternative 2, a total of 28,272 flares would be expended during training flare exercises, a 390 percent increase over the No Action Alternative.

Summary of Training Activities

The increase in expended materials under Alternative 2 would increase the probability of ingestion risk; however, as discussed under the No Action Alternative, the likelihood of ingestion would still be low based on the dispersed nature of the materials and the limited exposure of those items at the surface/water column or seafloor where certain fishes could be at risk of ingesting those items. Therefore, the number of fish potentially impacted by ingestion of expended materials would be low and population-level impacts would not occur.

Testing Activities

Projectiles

Under Alternative 2, a total of 2,500 small-caliber projectiles would be expended during testing activities. Under Alternative 2, a total of 8,335 explosive munitions (projectiles, missiles, and torpedoes) would be expended during testing activities. These explosive items would be detonated with fragments expended in the Study Area.

Sonobuoys

Under Alternative 2, a total of 2,228 sonobuoys would be expended during testing activities.

Chaff and Flares

Under Alternative 2, 660 chaff cartridges and 330 flares would be expended during testing exercises.

Summary of Testing Activities

The increase in expended materials under Alternative 2 would increase the probability of ingestion risk; however, as discussed under Alternative 1, the likelihood of ingestion would still be low based on the dispersed nature of the materials and the limited exposure of those items at the surface/water column or seafloor where certain fishes could be at risk of ingesting those items. Therefore, the number of fish potentially impacted by ingestion of expended materials would be low and population-level impacts would not occur.

3.9.3.5.2 Summary and Conclusions of Ingestion Impacts

3.9.3.5.2.1 Combined Ingestion Stressors

An individual fish could experience the following consequences of ingestion stressors: stress, behavioral changes, ingestion causing injury, and ingestion causing mortality. Ingestion causing mortality cannot act in combination because mortal injuries occur with the first instance. Therefore, there is no possibility for the occurrence of this consequence to increase if sub-stressors are combined.

Sub-lethal consequences may result in delayed mortality because they cause irrecoverable injury or alter the individual's ability to feed or detect and avoid predation. Normally, for fish large enough to ingest it, most small-caliber projectiles would pass through a fish's digestive system without injury. However, in this scenario it is possible that a fish's digestive system could already be compromised or blocked in such a manner that the small-caliber projectiles can no longer easily pass through without harm. It is conceivable that a fish could first ingest a small bomb fragment that might damage or block its digestive tract, then ingest a small-caliber projectile, with magnified combined impacts. The frequency of sub-lethal consequences resulting in mortality could be magnified as a result of ingestion stressors acting in combination only if the combined activities occur in essentially the same location and occur within the individual's recovery time from the first disturbance. This circumstance is likely to arise only during training and testing activities that cause frequent and recurring ingestion stressors to essentially the same location (e.g., chaff cartridge end caps/flares expended at the same location as small-caliber projectiles). In these specific circumstances the potential consequences to fishes from combinations of ingestion stressors may be greater than the sum of their individual consequences.

These specific circumstances that could magnify the consequences of ingestion stressors are highly unlikely to occur because, with the exception of a sinking exercise, it is highly unlikely that chaff cartridge end caps/flares and small-caliber projectiles would impact essentially the same location because most of these sub-stressors are widely dispersed in time and space.

The combined impact of these sub-stressors does not increase the risk in a meaningful way because the risk of injury or mortality is extremely low for each sub-stressor independently. While it is conceivable that interaction between sub-stressors could magnify their combined risks, the necessary circumstances are highly unlikely to overlap. Interaction between ingestion sub-stressors is likely to have neutral consequences for fishes.

3.9.3.5.2.2 Summary and Conclusions of Ingestion Impacts

The Navy identified and analyzed three military expended materials types that have ingestion potential for fishes: non-explosive practice munitions, military expended materials from high explosives, and military expended materials from non-ordnance items (e.g., end caps, canisters, chaff, and accessory materials). The probability of fishes ingesting military expended materials depends on factors such as the size, location, composition, and buoyancy of the expended material. These factors, combined with the location and feeding behavior of fishes, were used to analyze the likelihood the expended material would be mistaken for prey and what the potential impacts would be if ingested. Most expended materials, such as large- and medium-caliber ordnance, would be too large to be ingested by a fish, but other materials, such as small-caliber munitions or some fragments of larger items, may be small enough to be swallowed by some fishes. During normal feeding behavior, many fishes ingest nonfood items and often reject (spit out) nonfood items prior to swallowing. Other fishes may ingest and swallow both food and nonfood items indiscriminately. There are concentrated areas where bombing, missile, and gunnery activities generate materials that could be ingested. However, even within those areas, the overall impact on fishes would be inconsequential.

The potential impacts of military expended material ingestion would be limited to individual cases where a fish might suffer a negative response—for example, ingesting an item too large, sharp, or pointed to pass through the digestive tract without causing damage. Based on available information, it is not possible to accurately estimate actual ingestion rates or responses of individual fishes. Nonetheless, the number of military expended materials ingested by fishes is expected to be very low and only an extremely small percentage of the total would be potentially encountered by fishes. Certain feeding behavior such as "suction feeding" along the seafloor exhibited by sturgeon may increase the probability of ingesting military expended materials relative to other fishes; however, encounter rates would still remain low.

3.9.3.6 Secondary Stressors

This section analyzes potential impacts on fishes exposed to stressors indirectly through impacts on habitat, sediment, or water quality, and prey availability. These are also primary elements of marine fish habitat and firm distinctions between indirect impacts and habitat impacts are difficult to maintain. For the purposes of this analysis, indirect impacts on fishes via sediment or water which 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 or its ecosystem.

Stressors from training and testing activities could pose secondary or indirect impacts on fishes via habitat, sediment, and water quality. These include: (1) explosives and byproducts; (2) metals; (3) chemicals; (4) other materials such as targets, chaff, and plastics; and (5) impacts on fish habitat. Activities associated with these stressors are detailed in Tables 2.8-1 to 2.8-4, and analyses of their potential impacts are discussed in Section 3.1 (Sediments and Water Quality) and Section 3.3 (Marine Habitats).

3.9.3.6.1 Explosives

In addition to directly impacting fish and fish habitat, underwater explosions could impact other species in the food web including plankton and other prey species that fish feed upon. The impacts of underwater explosions would differ depending upon the type of prey species in the area of the blast. As discussed in Section 3.9.3.1 (Acoustic Stressors), fish with swim bladders are more susceptible to blast injuries than fish without swim bladders.

In addition to physical impacts 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. This startle and flight response is the most common secondary defense among animals (Hanlon and Messenger 1996). The sound from underwater explosions might induce startle reactions and temporary dispersal of schooling fishes if they are within close proximity. The abundances of fish and invertebrate prey species near the detonation point could be diminished for a short period of time before being repopulated by animals from adjacent waters. Alternatively, any prey species that would be directly injured or killed by the blast could draw in scavengers from the surrounding waters that would feed on those organisms, and in turn could be susceptible to becoming directly injured or killed by subsequent explosions. 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. Indirect impacts of underwater detonations and explosive ordnance use under the proposed action would not result in a decrease in the quantity or quality of fish populations or fish habitats in the Study Area.

3.9.3.6.2 Explosive 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 explosives. Undetonated explosives associated with ordnance disposal and mine clearance are collected after training is complete; therefore, potential impacts are assumed to be inconsequential for these training and testing activities, but other activities could leave these items on the seafloor. Fishes may be exposed by contact with the explosive, contact with contaminants in the sediment or water, and ingestion of contaminated sediments.

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 remainders are rapidly diluted below threshold impact level. Explosive byproducts associated with high order detonations present no indirect impacts to fishes through sediment or water. However, low order detonations and unexploded ordnance present elevated likelihood of impacts on fishes.

Indirect impacts of explosives and unexploded ordnance to fishes via sediment is possible in the immediate vicinity of the ordnance. Degradation of explosives proceeds via several pathways discussed in Section 3.1 (Sediments and Water Quality). Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen and Lotufo 2010). TNT and its degradation products impact developmental processes in fishes and are acutely toxic to adults at concentrations similar to real-world exposures (Halpern et al. 2008; Rosen and Lotufo 2010). Relatively low solubility of most explosives and their degradation products means that concentrations of these contaminants in the water are relatively low and readily diluted. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately 6 to 12 in. (15.2 to 30.5 m) away from degrading ordnance, the concentrations of these compounds were not statistically distinguishable from background beyond 3 to 6 ft. (0.9 to 1.8 m) from the degrading ordnance (see Section 3.1, Sediments and Water Quality). Taken together, it is likely that various lifestages of fishes could be impacted by the indirect impacts of degrading explosives within a very small radius of the explosive (1–6 ft. [0.3–1.8 m]).

3.9.3.6.3 Metals

Certain metals are harmful to fishes at concentrations above background levels (e.g., cadmium, chromium, lead, mercury, zinc, copper, manganese, and many others) (Wang and Rainbow 2008). Metals are introduced into seawater and sediments as a result of Navy 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 (see Section 3.3, Marine Habitats, and Chapter 4, Cumulative Impacts). Indirect impacts of metals to fishes via sediment and water involve concentrations several orders of magnitude lower than concentrations achieved via bioaccumulation. Fishes 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 fishes would be indirectly impacted by toxic metals via the water.

3.9.3.6.4 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 (Sediments and Water Quality), but there is no additional risk to fishes 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.

The greatest risk to fishes from flares, missile, and rocket propellants is perchlorate which is highly soluble in water, persistent, and impacts metabolic processes in many plants and animals. Fishes may be exposed by contact with contaminated water or ingestion of contaminated sediments. Since perchlorate is highly soluble, it does not readily absorb to sediments. Therefore, missile and rocket fuel poses no risk of indirect impact on fishes via sediment. In contrast, the principal toxic components of torpedo fuel, propylene glycol dinitrate and nitrodiphenylamine, adsorbs to sediments, has relatively low toxicity, and is readily degraded by biological processes (Section 3.1, Sediments and Water Quality). It is conceivable that various lifestages of fishes could be indirectly impacted by propellants via sediment in the immediate vicinity of the object (e.g., within a few inches), but these potential impacts would diminish rapidly as the propellant degrades.

3.9.3.6.5 Other Materials

Some military expended materials (e.g., decelerators/parachutes) could become remobilized after their initial contact with the sea floor (e.g., by waves or currents) and could be reintroduced as an entanglement or ingestion hazard for fishes. In some bottom types (without strong currents, hard-packed sediments, and low biological productivity), items such as projectiles might remain intact for some time before becoming degraded or broken down by natural processes. While these items remain intact sitting on the bottom, they could potentially remain ingestion hazards. These potential impacts may cease only (1) when the military expended materials is too massive to be mobilized by typical oceanographic processes, (2) if the military expended materials becomes encrusted by natural processes and incorporated into the seafloor, or (3) when the military expended materials becomes permanently buried. In this scenario, a parachute could initially sink to the seafloor, but then be transported laterally through the water column or along the seafloor, increasing the opportunity for entanglement. In the unlikely event that a fish would become entangled, injury or mortality could result. The entanglement stressor would eventually cease to pose an entanglement risk as it becomes encrusted or buried, or degrades.

3.9.3.6.6 Impacts on Fish Habitat

The Proposed Action could result in localized and temporary changes to the benthic community during activities that impact fish habitat. Fish habitat could become degraded during activities that would strike the seafloor or introduce military expended materials, bombs, projectiles, missiles, rockets, or fragments to the seafloor. During, or following activities that impact benthic habitats, fish species may experience loss of available benthic prey at locations in the Study Area where these items might be expended on EFH or habitat areas of particular concern. Additionally, plankton and zooplankton that are eaten by fish may also be negatively impacted by these same expended materials.

Impacts of physical disturbance and strike by small, medium, and large projectiles would be concentrated within designated gunnery box areas, resulting in localized disturbances of hard bottom areas, but could occur anywhere in the Study Area. Hard bottom is important habitat for many different species of fish, including those fishes managed by various fishery management plans.

When a projectile hits a biogenic habitat, the substrate immediately below the projectile is not available at that habitat type on a long-term basis, until the material corrodes. The substrate surrounding the projectile would be disturbed, possibly resulting in short-term localized increased turbidity. Given the large spatial area of the range complexes, it is unlikely that most of the small, medium, and large projectiles expended in the Study Area would fall onto this habitat type. Furthermore, these activities are distributed within discrete locations within the Study Area, and the overall footprint of these areas is quite small with respect to the spatial extent of this biogenic habitat within the Study Area.

Sinking exercises could also provide secondary impacts on deep sea populations. These activities occur in open-ocean areas, outside of the coastal range complexes, with potential direct disturbance or strike impacts on deep sea fishes. Secondary impacts on these fishes could occur after the ship hulks sink to the seafloor. Over time, the ship hulk would be colonized by marine organisms that attach to hard surfaces. For fishes that feed on these types of organisms, or whose abundances are limited by available hard structural habitat, the ships that are sunk during sinking exercises could provide an incidental beneficial impact on the fish community (Love and York 2005; Quattrini and Ross 2006).

3.9.4 Summary of Potential Impacts on Fish

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 individual stressor are discussed in the analyses of each stressor in the sections above.

There are generally two ways that a fish could be exposed to multiple stressors. The first would be if a fish were exposed to multiple sources of stress from a single activity (e.g., a mine warfare activity 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 of effects of each stressor 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 fish were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously. This would be even more likely to occur during large-scale exercises or activities that span a period of days or weeks (such as a sinking exercises or composite training unit exercise).

Fish 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 and in areas that individual fish frequent because it is within the animal's home range (including spawning and feeding areas) or migratory corridor. Except for in the few concentration 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 fish 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 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 (the order of a few hours or less).

Multiple stressors may also have synergistic effects. For example, fish 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. Fish 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 to certain fish species from the Proposed Action may include injury or mortality, impacts are not expected to decrease the overall fitness of any given population. Mitigation measures designed to reduce the potential impacts are discussed in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring).

This Page Intentionally Left Blank

REFERENCES

Able, K. W. & Fahay, M. P. (1998). The first year in the life of estuarine fishes in the Middle Atlantic Bight: Rutgers University Press.

Adams, P. B., Grimes, C.B., Hightower, J.E., Lindley, S.T. & Moser, M.L. (2002). Status Review for North American Green Sturgeon, Acipenser medirostris, National Marine Fisheries Service, North Carolina Cooperative Fish and Wildlife Research Unit, 49.

Amoser, S. & Ladich, F. (2003). Diversity in noise-induced temporary hearing loss in otophysine fishes. *Journal of the Acoustical Society of America,* 113(4), 2170-2179.

Amoser, S. & Ladich, F. (2005). Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? *Journal of Experimental Biology,* 208, 3533-3542.

Arfsten, D. P., Wilson, C.L. & Spargo, B. (2002). Radio frequency chaff: The effects of its use in training on the environment. *Ecotoxicology and Environmental Safety,* 53(1), 1-11.

Astrup, J. (1999). Ultrasound detection in fish - a parallel to the sonar-mediated detection of bats by ultrasound-sensitive insects? *Comparative Biochemistry and Physiology a-Molecular & Integrative Physiology,* 124(1), 19-27.

Astrup, J. & Møhl, B. (1993). Detection of intense ultrasound by the cod Gadus morhua. *Journal of Experimental Biology*, 182, 71-80.

Atema, J., Kingsford, M.J., & Gerlach, G. (2002). Larval reef fish could use odour for detection, retention and orientation to reefs. *Marine Ecology Progress Series,* 241, 151-160.

Bakun, A., Babcock, E.A., Lluch-Cota, S.E., Santora, C. & and Salvadeo, C.J. (2010). Issues of ecosystem-based management of forage fisheries in ‘‘open’’ non-stationary ecosystems: The example of the sardine fishery in the Gulf of California. *Reviews in Fish Biology and Fisheries,* 20, 9-29.

Bleckmann, H. and R. Zelick. (2009). "Lateral line system of fish." Integr Zool 4(1): 13-25.

Boehlert, G. W. & Gill, A. B. (2010). Environmental and Ecological Effects of Ocean Renewable Energy Development; A Current Synthesis. *Oceanography, 23*(2), 68-81.

Booman, C., Dalen, H., Heivestad, H., Levsen, A., van der Meeren, T. & Toklum, K. (1996). (Seismic-fish) Effekter av luftkanonskyting pa egg, larver og ynell. Havforskningsinstituttet.

Brander, K. (2010). Impact of climate change on fisheries. *Journal of Marine Systems,* 79, 389-402.

Brander, K. M. (2007). Global fish production and climate change. Proceedings of the National Academy of Sciences of the United States of America, 104(50), 19709-19714.

Brehmer, P., Gerlotto, F., Laurent, C., Cotel, P., Achury, A. & Samb, B. (2007). Schooling behaviour of small pelagic fish: Phenotypic expression of independent stimuli. *Marine Ecology Progress Series,* 334, 263-272.

Botsford, L. W., Brumbaugh, D. R., Grimes, C., Kellner, J. B., Largier, J., O'Farrell, M. R., Wespestad, V. (2009). Connectivity, Sustainability, and Yield: Bridging the Gap Between Conventional Fisheries Management and Marine Protected Areas. [Review]. *Reviews in Fish Biology and Fisheries, 19*(1), 69-95. 10.1007/s11160-008-9092-z

Buerkle, U. (1968). Relation of pure tone thresholds to background noise level in the Atlantic cod (Gadus morhua). *Journal of the Fisheries Research Board of Canada,* 25, 1155–1160.

Buerkle, U. (1969). Auditory masking and the critical band in Atlantic cod (Gadus morhua). *Journal of the Fisheries Research Board of Canada,* 26, 1113-1119.

Bullock, T. H., Bodznick, D. A. & Northcutt, R. G. (1983). The Phylogenetic Distribution of Electroreception - Evidence for Convergent Evolution of a Primitive Vertebrate Sense Modality. *Brain Research Reviews, 6*(1), 25-46. 10.1016/0165-0173(83)90003-6

Buran, B. N., Deng, X. & Popper, A.N. (2005). Structural variation in the inner ears of four deep-sea elopomorph fishes. *Journal of Morphology,* 265(215-225), 215-225.

California Department of Transportation. (2001). San Francisco - Oakland Bay Bridge East Span Seismic Safety Project: Pile Installation Demonstration Project: Marine Mammal Impact Assessment, 65.

Carlson, T., Hastings, M. & Popper, A.N. (2007). Memorandum: Update on Recommendations for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities, 8.

Casper, B. M., Lobel, P.S. & Yan, H. (2003). The hearing sensitivity of the little skate, Raja erinacea: A comparison of two methods. *Environmental Biology of Fishes,* 68, 371-379.

Casper, B. M. & Mann, D.A. (2006). Evoked potential audiograms of the nurse shark (Ginglymostoma cirratum) and the yellow stingray (Urobatis jamaicensis). *Environmental Biology of Fishes,* 76, 101-108.

Casper, B. M. & Mann, D.A. (2009). Field hearing measurements of the Atlantic sharpnose shark Rhizoprionodon terraenovae. *Journal of Fish Biology,* 75, 2768-2776.

Cato, D. H. (1978). Marine biological choruses observed in tropical waters near Australia. *Journal of the Acoustical Society of America*, 64(3), 736-743.

Chapman, C. J. & Hawkins, A.D. (1973). A field study of hearing in the cod, Gadus morhua. *Journal of Comparative Physiology,* 85, 147-167.

Cheung, W. W. L., Watson, R., Morato, T., Pitcher, T.J. & Pauly, D. (2007). Intrinsic vulnerability in the global fish catch. *Marine Ecology-Progress Series,* 333, 1-12.

Codarin, A., Wysocki, L. E., Ladich, F. & Picciulin, M. (2009). Effects of ambient and boat noise on hearing and communication in three fish species living in a marine protected area (Miramare, Italy). *Marine Pollution Bulletin,* 58(12), 1880-1887.

Continental Shelf Associates (CSA). (2004). Explosive removal of offshore structures - information synthesis report. Continental Shelf Associates Inc. U. S. D. o. t. Interior. New Orleans, LA, Minerals Management Service, Gulf of Mexico OCS Region.

Coombs, S. & Popper, A.N. (1979). Hearing differences among Hawaiian squirrelfish (family Holicentridae) related to differences in the peripheral auditory system. *Journal of Comparative Physiology A,* 132, 203-207.

Craig Jr., J. C. (2001). Appendix D, Physical Impacts of Explosions on Marine Mammals and Turtles. Final Environmental Impact Statement, Shock Trial of the WINSTON CHURCHILL (DDG 81), U.S. Department of the Navy, Naval Sea Systems Command (NAVSEA): 43.

Crain, C. M., Halpern, B.S., Beck, M.W. & Kappel, C.V. (2009). *Understanding and Managing Human Threats to the Coastal Marine Environment.* In The Year in Ecology and Conservation Biology, 2009. R. S. Ostfeld and W. H. Schlesinger. Oxford, UK, Blackwell Publishing. 1162, 39-62.

Culik, B. M., Koschinski, S., Tregenza, N. & Ellis, G.M. (2001). Reactions of harbor porpoises Phocoena phocoena and herring Clupea harengus to acoustic alarms. *Marine Ecology Progress Series,* 211, 255-260.

Danner, G. R., Chacko, J. & Brautigam. F. (2009). Voluntary ingestion of soft plastic fishing lures affects brook trout growth in the laboratory. *North American Journal of Fisheries Management,* 29(2), 352-360.

Dempster, T. and M. Taquet. (2004). "Fish aggregation device (FAD) research: gaps in current knowledge and future directions for ecological studies." Reviews in Fish Biology and Fisheries 14(1): 21-42.

Deng, X., Wagner, H.-J. & Popper, A.N. (2011). The inner ear and its coupling to the swim bladder in the deep-sea fish Antimora rostrata (Teleostei: Moridae). *Deep-Sea Research I*, 58, 27-37.

Derraik, J. G. B. (2002). The pollution of the marine environment by plastic debris: A review. *Marine Pollution Bulletin*, 44(9), 842-852.

Doksaeter, L., Godo, O.R., Handegard, N.O., Kvadsheim, P.H., Lam, F.P.A., Donovan, C. & Miller, P. J. O. (2009). Behavioral responses of herring (Clupea harengus) to 1–2 and 6–7 kHz sonar signals and killer whale feeding sounds. *The Journal of the Acoustical Society of America,* 125(1), 554-564.

Drazen, J. C. & Seibel, B.A. (2007). Depth-related trends in metabolism of benthic and benthopelagic deep-sea fishes. *Limnology and Oceanography,* 52(5), 2306-2316.

Dufour, F., Arrizabalaga, H., Irigoien, X., & Santiago, J. (2010). Climate impacts on albacore and bluefin tunas migrations phenology and spatial distribution. *Progress in Oceanography,* 86(1-2), 283-290.

Dulvy, N. K., Sadovy, Y. & Reynolds, J. D. (2003). Extinction vulnerability in marine populations. *Fish and Fisheries,* 4(1), 25-64.

Dunning, D. J., Ross, Q.E., Geoghegan, P., Reichle, J., Menezes, J. & Watson, J. (1992). Alewives avoid high-frequency sound. *North American Journal of Fisheries Management*, 12, 407-416.

Dzwilewski, P. T. and G. Fenton. (2002). Shock wave / sound propagation modeling results for calculating marine protected species impact zones during explosive removal of offshore structures. ARA PROJECT 5604. New Orleans, LA, Applied Research Associates Inc., for Minerals Management Service: 1-37.

Edds-Walton, P. L. and J. Finneran. (2006). Evaluation of Evidence for Altered Behavior and Auditory Deficits in Fishes Due to Human-Generated Noise Sources. D. D. o. t. Navy). SSC San Diego San Diego, CA 92152-5001: 50.

Egner, S. A. & Mann, D.A. (2005). Auditory sensitivity of sergeant major damselfish Abudefduf saxatilis from post-settlement juvenile to adult. *Marine Ecology Progress Series,* 285, 213-222.

Engås, A. & Løkkeborg, S. (2002). Effects of seismic shooting and vessel-generated noise on fish behaviour and catch rates. *Bioacoustics*, 12, 313-315.

Engås, A., Løkkeborg, S., Ona, E. & Soldal, V. (1996). Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus). *Canadian Journal of Fisheries and Aquatic Sciences*, 53, 2238-2249.

Enger, P. S. (1981). Frequency discrimination in teleosts-central or peripheral? Hearing and Sound Communication in Fishes. W. N. Tavolga, A. N. Popper and R. R. Fay. New York, Springer-Verlag: 243-255.

Environmental Sciences Group. (2005). CFMETR Environmental Assessment Update 2005. Kingston, Ontario, Environmental Sciences Group, Royal Military College: 652.

Estrada, J. A., Rice, A.N., Lutcavage, M.E. & Skomal, G. B. (2003). Predicting trophic position in sharks of the north-west Atlantic Ocean using stable isotope analysis. *Journal of the Marine Biological Association of the United Kingdom,* 83, 1347-1350.

Fay, R. R. (1988). *Hearing in vertebrates: A psychophysics handbook*. Winnetka, Illinois, Hill-Fay Associates.

Fay, R. R. & Megela-Simmons, A. (1999). The sense of hearing in fishes and amphibians. Comparative Hearing: Fish and Amphibians. R. R. Fay and A. N. Popper. New York, Springer-Verlag: 269-318.

Feist, B. E., Anderson, J.J. & Miyamoto, R. (1992). Potential Impacts of Pile Driving on Juvenile Pink (Oncorhynchus gorbuscha) and Chum (O. keta) Salmon Behavior and Distribution, University of Washington, 66.

Felix, A., Stevens, M. E. & Wallace, R. L. (1995). Unpalatability of a Colonial Rotifer, Sinantherina socialis to Small Zooplanktivorous Fishes. Invertebrate Biology, 114(2), 139-144. 10.2307/3226885

Fitch, J. E. & Young, P.H. (1948). Use and effect of explosives in California coastal waters. California Division Fish and Game.

Formicki, K., Tanski, A., Sadowski, M. & Winnicki, A. (2004). Effects of magnetic fields on fyke net performance. *Journal of Applied Ichthyology, 20*(5), 402-406. 10.1111/j.1439-0426.2004.00568.x

Froese, R. & Pauly, D. (2010). FishBase. 2010: World Wide Web electronic publication.

Gannon, D. P., Barros, N.B., Nowacek, D.P., Read, A.J., Waples, D.M. & Wells, R.S. (2005). Prey detection by bottlenose dolphins (Tursiops truncatus): an experimental test of the passive listening hypothesis. *Animal Behaviour*, 69, 709-720.

Gearin, P. J., Gosho, M.E., Laake, J.L. L., Cooke, L., Delong, R.L. & Hughes, K.M. (2000). Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, Phoceona phocoena, in the State of Washington. 2(1), 1-9.

Gill, A. B. (2005). Offshore renewable energy: ecological implications of generating electricity in the coastal zone. *Journal of Applied Ecology, 42*(4), 605-615. 10.1111/j.1365-2664.2005.01060.x

Glover, A. G. & Smith, C.R. (2003). The deep-sea floor ecosystem: Current status and prospects of anthropogenic change by the year 2025. *Environmental Conservation,* 30(3), 219-241.

Goatley, C. H. R. & Bellwood, D.R. (2009). Morphological structure in a reef fish assemblage. *Coral Reefs*, 28, 449-457.

Goertner, J.F. (1982). Prediction of Underwater Explosion Safe Ranges for Sea Mammals. Research and Technology Department. NSWC TR 82-188.

Goertner, J. F., Wiley, M. L., Young, G. A. & McDonald, W. W. (1994). Effects of underwater explosions on fish without swimbladders. (NSWC TR 88-114). Silver Spring, MD: Naval Surface Warfare Center.

Goncalves, R., Scholze, M., Ferreira, A.M., Martins, M. & Correia, A.D. (2008). The joint effect of polycyclic aromatic hydrocarbons on fish behavior. *Environmental Research*, 108(2), 205-213.

Govoni, J. J., Settle, L. R., & West, M.A. (2003). Trauma to juvenile pinfish and spot inflicted by submarine detonations. *Journal of Aquatic Animal Health,* 15, 111-119.

Gregory, J. & Clabburn, P. (2003). Avoidance behaviour of Alosa fallax fallax to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river. *Aquatic Living Resources,* 16, 313-316.

Haedrich, R. L. (1996). Deep-water fishes: Evolution and adaptation in the earth's largest living spaces. *Journal of Fish Biology,* 49, 40-53.

Halpern, B. S., Walbridge, S., Selkoe, K.A., Kappel, C.V., Micheli, F., D'Agrosa, C., Brunco, J.F., Casey, K. S., Ebert, C., Fox, H.E., Fujita, R., Heinemann, D., Lenihan, H. S., Madin, E. M. P., Perry, M. T., Selig, E. R., Spalding, M., Steneck, R. & Watson, R. (2008). A global map of human impact on marine ecosystems. *Science*, 319(5865), 948-952.

Halvorsen, M. B., Zeddies, D.A., Choicoine, D.R. & Popper, A.N. (2012). Effects of mid-frequency active sonar on hearing in fish. *Journal of the Acoustical Society of America* 131(1), 599-607.

Hansen, L. P. & Windsor, M.L. (2006). Interactions between aquaculture and wild stocks of Atlantic salmon and other diadromous fish species: Science and management, challenges and solutions. *ICES Journal of Marine Science,* 63(7), 1159-1161.

Hastings, M. C. (1990). Effects of underwater sound on fish.

Hastings, M. C. (1995). Physical effects of noise on fishes. Proceedings of INTER-NOISE 95, The 1995 International Congress on Noise Control Engineering.

Hastings, M. C. & Popper, A. N. (2005). Effects of sound on fish. Report to Cal Trans: 1-82.

Hastings, M. C., Popper, A.N., Finneran, J. & Lanford, P. (1996). Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish Astronotus ocellatus. *Journal of the Acoustical Society of America*, 99(3), 1759-1766.

Hastings, M. C., Reid, C. A.,Grebe, C.C., Hearn, R.L. & Colman, J. G. (2008). The effects of seismic airgun noise on the hearing sensitivity of tropical reef fishes at Scott Reef, Western Australia. Proceedings of the Institute of Acoustics 30(5), 8 pp.

Hartwell, S. I., Hocutt, C. H. & van Heukelem, W. F. (1991). Swimming response of menhaden (*Brevoortia tyrannus*) to electromagnetic pulses. *Journal of Applied Ichthyology, 7*(2), 90-94.

Hawkins, A. D. & Johnstone, A.D.F. (1978). The hearing of the Atlantic salmon, Salmo salar. *Journal of Fish Biology,* 13, 655-673.

HDR EOC. (2012). Draft: Guam and Saipan marine species monitoring winter-spring survey, March 2012. Submitted to Naval Facilities Engineering Command (NAVFAC) Pacific, Pearl Harbor, Hawaii, under Contract No. N62470-10-D-3011 Task Order 17, issued to HDR Inc. 19 pp.

Helfman, G. S., Collette, B.B., & Facey, D.E. (1997). The Diversity of Fishes. Malden, MA, Blackwell Science: 528.

Helfman, G. S., Collette, B. B., Facey, D. E. & Bowen, B. W. (2009). The Diversity of Fishes. In Wiley-Blackwell (Ed.) (Second ed.).

Higgs, D. M. (2005). Auditory cues as ecological signals for marine fishes. Marine Ecology Progress Series 287, 278-281.

Higgs, D. M., Plachta, D. T. T., Rollo, A.K., Singheiser, M., Hastings, M.C. & Popper, A.N. (2004). Development of ultrasound detection in American shad (Alosa sapidissima). *Journal of Experimental Biology,* 207, 155-163.

Hoss, D. E. & Settle, L. R. (1990). Ingestion of plastics by teleost fishes. In Proceedings of the Second International Conference on Marine Debris. S. Shomura and M. L. Godfrey. Honolulu, HI, US Department of Commerce, National Oceanic and Atmospheric Administration: 693-709.

International Union for Conservation of Nature. (2009). Red List of Threatened Species. Version 2009.2. Barcelona, International Union for Conservation of Nature and Natural Resources. 2010.

Iversen, R. T. B. (1967). Response of the yellowfin tuna (*Thunnus albacares*) to underwater sound. Marine Bio-Acoustics II. W. N. Tavolga. New York, Pergamon Press.

Iversen, R. T. B. (1969). Auditory thresholds of the scombrid fish Euthynnus affinis, with comments on the use of sound in tuna fishing. FAO Conference on Fish Behaviour in Relation to Fishing Techniques and Tactics, FAO Fisheries Reports No. 62. FRm/R62.3.

Jonsson, B., Waples, R. S., & Friedland, K.D. (1999). Extinction considerations for diadromous fishes. *ICES Journal of Marine Science,* 56(4), 405-409.

Jørgensen, R., Handegard, N.O.,Gjøsæter, H. & Slotte, A. (2004). Possible vessel avoidance behaviour of capelin in a feeding area and on a spawning ground. *Fisheries Research,* 69(2), 251-261.

Jørgensen, R., Olsen, K.K., Petersen, I. & Kanapthipplai, P. (2005). Investigations of potential effects of low frequency sonar signals on survival, development and behaviour of fish larvae and juveniles. Tromsø Norway, The Norwegian College of Fishery Science, University of Tromsø.

Kajiura, S. M. & Holland, K. N. (2002). Electroreception in Juvenile Scalloped Hammerhead and Sandbar Sharks. *The Journal of Experimental Biology, 205*, 3609-3621.

Kalmijn, A. J. (2000). Detection and processing of electromagnetic and near-field acoustic signals in elasmobranch fishes. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences, 355*(1401), 1135-1141. doi: 10.1098/rstb.2000.0654

Kane, A. S., Song, J., Halvorsen, M.B., Miller, D.L., Salierno, J.D., Wysocki, L.E., Zeddies, D. & Popper, A.N. (2010). Exposure of fish to high intensity sonar does not induce acute pathology. *Journal of Fish Biology.*

Kappel, C. V. (2005). Losing pieces of the puzzle: threats to marine, estuarine, and diadromous species. *Frontiers in Ecology and the Environment,* 3(5), 275-282.

Keevin, T. M. and G. L. Hempen. (1997). The environmental effects of underwater explosions with methods to mitigate impacts. St. Louis, MO.

Keller, A. A., Fruh, E.L., Johnson, M.M., Simon, V. & McGourty, C. (2010). Distribution and abundance of anthropogenic marine debris along the shelf and slope of the US West Coast. *Marine Pollution Bulletin,* 60(5), 692-700.

Kenyon, T. N. (1996). Ontogenetic changes in the auditory sensitivity of damselfishes (pomacentridae). *Journal of Comparative Physiology A,* 179, 553-561.

Ketten, D. R. (1998). Marine Mammal Auditory Systems: A Summary of Audiometric and Anatomical Data and its Implications for Underwater Acoustic Impacts. La Jolla, CA, U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center: 74.

Koslow, J. A. (1996). Energetic and life-history patterns of deep-sea benthic, benthopelagic and seamount-associated fish. *Journal of Fish Biology,* 49(Supplement A), 54-74.

Kuparinen, A. & Merila, J. (2007). Detecting and managing fisheries-induced evolution. *Trends in Ecology & Evolution,* 22(12), 652-659.

Kvadsheim, P. H. & Sevaldsen, E. M. (2005). The potential impact of 1-8 kHz active sonar on stocks of juvenile fish during sonar exercises, Forsvarets Forskningsinstitutt Norwegian Defence Research Establishment. P O Box 25, NO-2027 Kjeller, Norway. FFI/RAPPORT-2005/01027.

Ladich, F. (2008). Sound communication in fishes and the influence of ambient and anthropogenic noise. *Bioacoustics,* 17, 35-37.

Ladich, F. & Popper, A. N. (2004). Parallel Evolution in Fish Hearing Organs. Evolution of the Vertebrate Auditory System, Springer Handbook of Auditory Research. G. A. Manley, A. N. Popper and R. R. Fay. New York, Springer-Verlag.

Laist, D. W. (1987). Overview of the biological effects of lost and discarded plastic debris in the marine environment. *Marine Pollution Bulletin,* 18(6B), 319-326.

Leysen, H., Jouk, P., Brunain, M., Christiaens, J.l & Adriaens, D. (2010). Cranial architecture of tube-snouted Gasterosteiformes (Syngnathus rostellatus and Hippocampus capensis). *Journal of morphology,* 271(3), 255-270.

Limburg, K. E. & Waldman, J. R. (2009). Dramatic declines in North Atlantic diadromous fishes. *Bioscience*, 59(11), 955-965.

Lombarte, A., H. Y. Yan, A. N. Popper, J. C. Chang and C. Platt. (1993). "Damage and regeneration of hair cell ciliary bundles in a fish ear following treatment with gentamicin." Hear. Res. 66: 166-174.

Lombarte, A. & Popper, A. N. (1994). Quantitative analyses of postembryonic hair cell addition in the otolithic endorgans of the inner ear of the European hake, Merluccius merluccius (Gadiformes, Teleostei). *Journal of Comparative Neurology,* 345, 419-428.

Lotufo, G. R., Blackburn, W., Marlborough, S.J. & Fleeger, J.W. (2010). Toxicity and bioaccumulation of TNT in marine fish in sediment exposures. *Ecotoxicology and Environmental Safety,* 73(7), 1720-1727.

Love, M. S. and A. York. (2005). "A comparison of the fish assemblages associated with an oil/gas pipeline and adjacent seafloor in the Santa Barbara Channel, southern California bight." Bulletin of Marine Science 77(1): 101-117.

Lovell, J., Findlay, M., Moate, R. & Yan, H. (2005). The hearing abilities of the prawn *Palaemon serratus*. *Comparative Biochemistry and Physiology, Part A, 140*, 89-100. Retrieved from www.elsevier.com/locate/cbpa

Luczkovich, J. J., Daniel III, H.J., Hutchinson, M., Jenkins, T., Johnson, S.E., Pullinger, R.C., & Sprague, M. W. (2000). Sounds of sex and death in the sea: bottlenose dolphin whistles suppress mating choruses of silver perch. *Bioacoustics*, 10(4), 323-334.

Macfadyen, G., Huntington, T. & Cappel, R. (2009). Abandoned, Lost or Otherwise Discarded Fishing Gear. Rome, Italy, United Nations Environment Programme Food, Food and Agriculture Organization of the United Nations,: 115.

Madsen, P. T., Wahlberg, M., Tougaard, J., Lucke, K. & Tyack, P. (2006). Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs. *Marine Ecology-Progress Series,* 309, 279-295.

Mahon, R., Brown, S.K., Zwanenburg, K.C.T., Atkinson, D.B., Buja, K.R., Claflin, L., Howell, G.D., Monaco, M.E., O'Boyle, R.N. & Sinclair, M. (1998). Assemblages and biogeography of demersal fishes of the east coast of North America. *Canadian Journal of Fisheries and Aquatic Sciences,* 55, 1704-1738.

Mann, D. A., Higgs, D. M., Tavolga, W., Souza, M. & Popper, A. (2001). Ultrasound detection by clupeiform fishes. *Journal of the Acoustical Society of America,* 109(6), 3048-3054.

Mann, D. A., Lu, Z., Hastings, M.C. & Popper, A.N. (1998). Detection of ultrasonic tones and simulated dolphin echolocation clicks by a teleost fish, the American shad (*Alosa sapidissima*). *Journal of the Acoustical Society of America*, 104(1), 562-568.

Mann, D. A., Lu, Z. & Popper, A. N. (1997). A clupeid fish can detect ultrasound. *Nature,* 389, 341.

Mann, D. A., Popper, A.N. & Wilson, B. (2005). Pacific herring hearing does not include ultrasound. *Biology Letters,* 1, 158-161.

Marcotte, M. M. & Lowe, C. G. (2008). Behavioral responses of two species of sharks to pulsed, direct current electrical fields: Testing a potential shark deterrent. *Marine Technology Society Journal, 42*(2), 53-61.

Marshall, N. J. (1996). Vision and sensory physiology - The lateral line systems of three deep-sea fish. *Journal of Fish Biology,* 49, 239-258.

McCauley, R. D. & Cato, D. H. (2000). Patterns of fish calling in a nearshore environment in the Great Barrier Reef. *Philosophical Transactions: Biological Sciences,* 355, 1289-1293.

McCauley, R. D., Fewtrell, J. Duncan,A. J., Jenner, C., M.-N. Jenner, M.-N., Pensrose, J. D., Prince, R.I.T., Adhitya, A., Murdoch, J. & McCabe, K.A. (2000). Marine seismic surveys: analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid, Centre for Marine Science and Technology, Curtin University.

McCauley, R. D., Fewtrell, J., & Popper, A. N. (2003). High intensity anthropogenic sound damages fish ears. *Journal of the Acoustical Society of America,* 113(1), 638-642.

McLennan, M. W. (1997). A simple model for water impact peak pressure and pulse width: a technical memorandum. Goleta, CA, Greeneridge Sciences Inc.

Meyer, M., Fay, R.R. & Popper, A.N. (2010). Frequency tuning and intensity coding of sound in the auditory periphery of the lake sturgeon, Acipenser fulvescens. *Journal of Experimental Biology,* 213, 1567-1578.

Miller, J. D. (1974). Effects of noise on people. *Journal of the Acoustical Society of America,* 56(3), 729-764.

Misund, O. A. (1997). Underwater acoustics in marine fisheries and fisheries research. *Reviews in Fish Biology and Fisheries*, 7, 1-34.

Moore, C. J. (2008). Synthetic polymers in the marine environment: A rapidly increasing, long-term threat. *Environmental Research,* 108(2), 131-139.

Morgan, L. & Chuenpagdee, R. (2003). Shifting Gears addressing the collateral impacts of fishing methods in U.S. waters. Island Press, Washington, D.C

Moyle, P. B. & Cech Jr., J.J. (1996). Fishes: An Introduction to Ichthyology. Upper Saddle River, NJ, Prentice Hall: 590.

Mueller-Blenkle, C., McGregor, P.K., Gill, A. B., Andersson, H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D. & Thomsen, F. (2010). Effects of Pile-Driving Noise on the Behaviour of Marine Fish, COWRIE Ltd.: 62.

Musick, J. A., Harbin, M.M., Berkeley, S.A., Burgess, G.H., Eklund, A.M., Findley, L. & Wright, S.G. (2000). Marine, estuarine, and diadromous fish stocks at risk of extinction in North America (exclusive of Pacific salmonids). *Fisheries,* 25(11), 6-30.

Myers, R. F. & Donaldson, T.J. (2003). The fishes of the Mariana Islands. *Micronesica* 35-56: 594-648.

Myrberg, A. A. (2001). The acoustical biology of elasmobranchs. *Environmental Biology of Fishes,* 60, 31-45.

Myrberg, A. A., Banner, A. & Richard, J.D. (1969). Shark attraction using a video-acoustic system. *Marine Biology*, 2(3), 264-276.

Myrberg, A. A., Gordon, C.R. & Klimley, A.P. (1976). Attraction of free ranging sharks by low frequency sound, with comments on its biological significance. Sound Reception in Fish. A. Schuijf and A. D. Hawkins. Amsterdam, Elsevier.

Myrberg, A. A., Ha, S.J., Walewski, S. & Banbury, J.C. (1972). Effectiveness of acoustic signals in attracting epipelagic sharks to an underwater sound source. *Bulletin of Marine Science,* 22, 926-949.

Myrberg, A. A. (1980). Ocean noise and the behavior of marine animals: relationships and implications. Advanced concepts in ocean measurements for marine biology. F. P. Diemer, F. J. Vernberg and D. Z. Mirkes, Univ.SouthCar.Press, 572pp: 461-491.

National Marine Fisheries Service. (2001). Final Environmental Impact Statement: Fishery Management Plan, Pelagic Fisheries of the Western Pacific Region. 1.

National Marine Fisheries Service. (2010). Species of Concern: Basking Shark (Cetorhinus maximus), NOAA National Marine Fisheries Service, Office of Protected Resources. 2010: Species of Concern factsheet.

National Oceanic and Atmospheric Administration. (1996). Magnuson Act provisions; Consolidation and update of regulations. Federal Register 61(85): 19390-19429.

National Oceanic and Atmospheric Administration. (2011). Draft Aquaculture Policy. Silver Spring, Maryland.

National Research Council (NRC). (1994). Low-frequency sound and marine mammals: Current knowledge and research needs. Washington, DC, National Academy Press.

National Research Council (NRC). (2003). Ocean Noise and Marine Mammals. Washington, DC, National Academies Press.

Nedwell, J., Turnpenny, A., Langworthy, J. & Edwards, B. (2003). Measurements of Underwater Noise During Piling at the Red Funnel Terminal, Southampton, and Observations of its Effect on Caged Fish. Bishop's Waltham, Hampshire, UK, Subacoustech Ltd.: 35.

Nelson, D. R. & Johnson, R.H. (1972). Acoustic attraction of Pacific reef sharks: effect of pulse intermittency and variability. *Comparative Biochemistry and Physiology Part A,* 42, 85-95.

Nelson, J. S. (2006). Fishes of the World. Hoboken, NJ, John Wiley & Sons: 601.

Nemeth, D. J. & Hocutt, C. H. (1990). Acute effects of electromagnetic pulses (EMP) on fish. *Journal of Applied Ichthyology, 6*(1), 59-64.

Nestler, J. M. (2002). Simulating movement patterns of blueback herring in a stratified southern impoundment. *Transactions of the American Fisheries Society,* 131, 55-69.

Newman, M. C. (1998). Uptake, biotransformation, detoxification, elimination, and accumulation. Fundamentals of ecotoxicology. Chelsea, MI, Ann Arbor Press: 25.

Nix, P. & Chapman P. (1985). Monitoring of underwater blasting operations in False Creek, British Columbia Proceedings of the workshop on effects of explosive use in the marine environment, Ottawa, Ontario, Environmental Protection Branch Technical Report No. 5, Canada Oil and Gas Lands Administration.

Normandeau, Exponent, T., T. & Gill, A. (2011). Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. Camarillo, CA: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region. Available from http://www.gomr.boemre.gov/PI/PDFImages/ESPIS/4/5115.pdf

O'Connell, C. P., Abel, D. C., Rice, P. H., Stroud, E. M. & Simuro, N. C. (2010). Responses of the southern stingray (*Dasyatis americana*) and the nurse shark (*Ginglymostoma cirratum*) to permanent magnets. *Marine and Freshwater Behaviour and Physiology, 43*(1), 63-73. doi: 10.1080/10236241003672230

O'Keeffe, D. J. and G. A. Young. (1984). Handbook on the Environmental Effects of Underwater Explosions, Naval Surface Weapons Center.

Ocean Conservancy. (2010). Trash travels: from our hands to the sea, around the globe, and through time. International Coastal Cleanup report. C. C. Fox, The Ocean conservancy: 60.

Ohman, M. C., Sigray, P. & Westerberg, H. (2007). Offshore windmills and the effects electromagnetic fields on fish. *Ambio, 36*(8), 630-633. doi: 10.1579/0044-7447(2007)36[630:OWATEO]2.0.CO;2

Ormerod, S. J. (2003). Current issues with fish and fisheries: Editor's overview and introduction. *Journal of Applied Ecology*, 40(2), 204-213.

Pauly, D. & Palomares, M.L. (2005). Fishing down marine food web: It is far more pervasive than we thought. *Bulletin of Marine Science,* 76(2), 197-211.

Paxton, J. R. & Eschmeyer, W.N. (1994). *Encyclopedia of Fishes*. San Diego, California, Academic Press.

Paxton, J. R. & Eschmeyer, W.N. (1998). *Encyclopedia of Fishes*. San Diego, California, Academic Press.

Pearson, W. H., Skalski, J.R., & Malme, C.I. (1987). Effects of sounds from a geophysical survey device on fishing success, Battelle/Marine Research Laboratory for the Marine Minerals Service, United States Department of the Interior.

Pearson, W. H., Skalski, J.R. & Malme, C.I. (1992). Effects of sounds from a geophysical survey device on behavior of captive Rockfish (Sebastes spp.). *Canadian Journal of Fisheries and Aquatic Sciences,* 49, 1343-1356.

Pew Oceans Commission. (2003). *America's Living Oceans: Charting a Course for Sea Change*. In A Report to the Nation. Arlington, VA, Pew Oceans Commission,: 144.

Pickering, A. D. (1981). *Stress and Fish*, Academic Press, New York.

Pitcher, T. J. (1986). Functions of shoaling behaviour in teleosts. In: The Behavior of Teleost Fishes. T. J. Pitcher. Baltimore, MD, The Johns Hopkins University Press: 294-337.

Pitcher, T. J. (1995). The impact of pelagic fish behaviour on fisheries. *Scientia Marina,* 59(3-4), 295-306.

Popper, A. N. (1977). A scanning electron microscopic study of the sacculus and lagena in the ears of fifteen species of teleost fishes. *Journal of Morphology,* 153, 397-418.

Popper, A. N. (1980). Scanning electron microscopic studies of the sacculus and lagena in several deep sea fishes. *American Journal of Anatatomy,* 157, 115 136.

Popper, A. N. (1981). Comparative scanning electron microscopic investigations of the sensory epithelia in the teleost sacculus and lagena. *Journal of Comparative Neurology*, 200, 357-374.

Popper, A. N. (2003). Effects of anthropogenic sounds on fishes. *Fisheries,* 28(10), 24-31.

Popper, A. N. (2008). Effects of Mid- and High-Frequency Sonars on Fish. Naval Undersea Warfare Center Division (NUWC). Newport, Rhode Island: 52.

Popper, A. N. & Carlson, T.J. (1998). Application of Sound and other Stimuli to Control Fish Behavior. *Transactions of the American Fisheries Society,* 127(5), 673-707.

Popper, A. N., Carlson, T.J., Hawkins, A.D., Southall, B.L. & Gentry, R.L. (2006). Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper: 15.

Popper, A. N. & Fay, R.R. (2010). Rethinking sound detection by fishes. *Hearing Research*.

Popper, A. N., Fay, R.R., Platt, C., & Sand, O. (2003). Sound detection mechanisms and capabilities of teleost fishes. Sensory Processing in Aquatic Environments. S. P. Collin and N. J. Marshall. New York, Springer-Verlag.

Popper, A. N., Halvorsen, M.B., Kane, A., Miller, D.L., Smith, M.E., Song, J., & Wysocki, L.E. (2007). The effects of high-intensity, low-frequency active sonar on rainbow trout. *Journal of the Acoustical Society of America,* 122(1), 623–635.

Popper, A. N. & Hastings, M.C. (2009a). The effects of anthropogenic sources of sound on fishes. *Journal of Fish Biology,* 75(3), 455-489.

Popper, A. N. & Hastings, M.C. (2009b). The effects of human-generated sound on fish. *Integrative Zoology,* 4, 43-52.

Popper, A. N. & Hastings, M.C. (2009c). Review Paper: The effects of anthropogenic sources of sound on fishes. *Journal of Fish Biology,* 75, 455-489.

Popper, A. N. & Hoxter, B. (1984). Growth of a fish ear: 1. Quantitative analysis of sensory hair cell and ganglion cell proliferation. *Hearing Research,* 15, 133-142.

Popper, A. N. & Hoxter, B. (1987). Sensory and nonsensory ciliated cells in the ear of the sea lamprey, Petromyzon marinus. *Brain, Behavior and Evolution,* 30, 43-61.

Popper, A. N., Plachta, D. T. T., Mann, D. & Higgs, D. (2004). Response of clupeid fish to ultrasound: a review. *ICES Journal of Marine Science,* 61, 1057-1061.

Popper, A. N. & Schilt, C.R. (2008). Hearing and acoustic behavior (basic and applied). *Fish Bioacoustics*. J. F. Webb, R. R. Fay and A. N. Popper. New York, Springer Science + Business Media, LLC.

Popper, A. N., Smith, M.E., Cott, P. A., Hanna, W., MacGillivray, A.O., Austin, M.E. & Mann, D.A. (2005). Effects of exposure to seismic airgun use on hearing of three fish species. *Journal of the Acoustical Society of America,* 117(6), 3958-3971.

Popper, A. N. & Tavolga, W. N. (1981). Structure and function of the ear in the marine catfish, Arius felis. *Journal of Comparative Physiology,* 144, 27-34.

Price, C. B., Brannon, J.M. & Yost, S.L. (1998). Transformation of RDX and HMX Under Controlled Eh/pH Conditions. Washington, DC, U.S. Army Corps of Engineers, Waterways Experiment Station: 34.

Quattrini, A. M. and S. W. Ross. (2006). "Fishes associated with North Carolina shelf-edge hardbottoms and initial assessment of a proposed Marine Protected Area." Bulletin of Marine Science 79(1): 137-163.

Ramcharitar, J., Higgs, D.M. & Popper, A.N. (2001). Sciaenid inner ears: a study in diversity. *Brain, Behavior and Evolution,* 58, 152-162.

Ramcharitar, J. & Popper, A.N. (2004). Masked auditory thresholds in sciaenid fishes: a comparative study. *Journal of the Acoustical Society of America,* 116(3), 1687-1691.

Ramcharitar, J. U., Deng, X., Ketten, D. & Popper, A.N. (2004). Form and function in the unique inner ear of a teleost: The silver perch (Bairdiella chrysoura). *Journal of Comparative Neurology,* 475(4), 531-539.

Ramcharitar, J. U., Higgs, D.M. & Popper, A. (2006). Audition in sciaenid fishes with different swim bladder-inner ear configurations. *Journal of the Acoustical Society of America,* 119(1), 439-443.

Remage-Healey, L., Nowacek, D.P. & Bass, A.H. (2006). Dolphin foraging sounds suppress calling and elevate stress hormone levels in a prey species, the Gulf toadfish. *Journal of Experimental Biology,* 209, 4444-4451.

Rex, M. A. & Etter, R. J. (1998). Bathymetric patterns of body size: implications for deep-sea biodiversity. *Deep-Sea Research II,* 45(1-3), 103-127.

Reynolds, J. D., Dulvy, N.K., Goodwin, N. B. & Hutchings, J.A. (2005). Biology of extinction risk in marine fishes. Proceedings of the Royal Society B-Biological Sciences 272(1579), 2337-2344.

Rickel, S. & Genin, A. (2005). Twilight transitions in coral reef fish: The input of light-induced changes in foraging behaviour. *Animal Behaviour,* 70(1), 133-144.

Rigg, D. P., Peverell, S. C., Hearndon, M. & Seymour, J. E. (2009). Do elasmobranch reactions to magnetic fields in water show promise for bycatch mitigation? *Marine and Freshwater Research, 60*(9), 942-948. doi: 10.1071/mf08180

Rosen, G. and G. R. Lotufo. (2010). "Fate and effects of Composition B in multispecies marine exposures." Environ Toxicol Chem 29(6): 1330-1337.

Rostad, A., S. Kaartvedt, T. A. Klevjer and W. Melle. (2006). "Fish are attracted to vessels." ICES Journal of Marine Science 63(8): 1431-1437.

Ross, Q. E. & Dunning, D. J. (1996). Reducing impingement of alewives with high-frequency sound at a power plant intake on Lake Ontario. *North American Journal of Fisheries Management,* 16, 548-559.

Rowat, D., Meekan, M. Engelhardt, U., Pardigon, B. & Vely, M. (2007). Aggregations of juvenile whale sharks (Rhincodon typus) in the Gulf of Tadjoura, Djibouti. *Environmental Biology of Fishes,* 80(4), 465-472.

Sabarros, P. S., Menard, F., Levenez, J.J., Tew-Kai, E. & Ternon, J.F. (2009). Mesoscale eddies influence distribution and aggregation patterns of micronekton in the Mozambique Channel. *Marine Ecology Progess Series,* 395, 101-107.

Sabates, A., Olivar, M. P., Salat, J., Palomera, I. & Alemany, F. (2007). Physical and Biological Processes Controlling the Distribution of Fish Larvae in the NW Mediterranean. *Progress in Oceanography, 74*(2-3), 355-376. 10.1016/j.pocean.2007.04.017

Saele, O., Solbakken, J.S., Watanabe, K., Hamre, K., Power, D. & Pittman, K. (2004). Staging of Atlantic halibut (Hippoglossus hippoglossus L.) from first feeding through metamorphosis, including cranial ossification independent of eye migration. *Aquaculture*, 239, 445-465.

Sancho, G. (2000). Predatory behaviors of Caranx melampygus (Carangidae) feeding on spawning reef fishes: A novel ambushing strategy. *Bulletin of Marine Science,* 66(2), 487-496.

Scholik, A. R. & Yan, H. Y. (2001). Effects of underwater noise on auditory sensitivity of a cyprinid fish. *Hearing Research,* 152(1-2), 17-24.

Scholik, A. R. & Yan, H. Y. (2002). Effects of boat engine noise on the auditory sensitivity of the fathead minnow, Pimephales promelas. *Environmental Biology of Fishes,* 63, 203-209.

Schwartz, A. L. (1985). The behavior of fishes in their acoustic environment. *Environmental Biology of Fishes,* 13(1), 3-15.

Scripps Institution of Oceanography & National Science Foundation. (2005). Environmental Assessment of a Planned Low-Energy Marine Seismic Survey by the Scripps Institution of Oceanography on the Louisville Ridge in the Southwest Pacific Ocean, January–February 2006. LaJolla, CA, and Arlington, VA, Scripps Institution of Oceanography, and the National Science Foundation.

Scripps Institution of Oceanography and National Science Foundation. (2008). Environmental Assessment of a marine geophysical survey by the R/V Melville in the Santa Barbara Channel, Scripps Institution of Oceanography, LaJolla, CA and National Science Foundation, Arlington, VA.

Seitz, J. C. & Poulakis, G. R. (2006). Anthropogenic effects on the smalltooth sawfish (Pristis pectinata) in the United States. *Marine Pollution Bulletin,* 52(11), 1533-1540.

Settle, L. R., Govoni, J.J., Greene, M. D. & West, M. A. (2002). Investigation of impacts of underwater explosions on larval and early juvenile fishes. *Fisheries and Oceans Canada*.

Sibert, J., Hampton, J., Kleiber, P. & Maunder, M. (2006). Biomass, size, and trophic status of top predators in the Pacific Ocean. *Science,* 314, 1773-1776.

Sisneros, J. A. & Bass, A. H. (2003). Seasonal plasticity of peripheral auditory frequency sensitivity. *The Journal of Neuroscience,* 23, 1049-1058.

Skalski, J. R., Pearson, W.H. & Malme, C. I. (1992). Effects of sounds from a geophysical survey device on catch-per unit-effort in a hook-and-line fishery for rockfish (Sebastes spp.). *Canadian Journal of Fisheries and Aquatic Sciences*, 49, 1357-1365.

Slabbekoorn, H., Bouton, N., van Opzeeland, I., Coers, A., ten Cate, C. & Popper, A.N. (2010). A noisy spring: The impact of globally rising underwater sound levels on fish. *Trends in Ecology and Evolution,* 25(7), 419-427.

Slotte, A., Kansen, K., Dalen, J. & Ona, E. (2004). Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fisheries Research,* 67, 143-150.

Smith, M. E., Coffin, A.B., Miller, D. L. & Popper, A.N. (2006). Anatomical and functional recovery of the goldfish (Carassius auratus) ear following noise exposure. *Journal of Experimental Biology,* 209, 4193-4202.

Smith, M. E., Kane, A,S, & Popper, A.N. (2004a). Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water? *Journal of Experimental Biology,* 207(Pt 20), 3591-3602.

Smith, M. E., Kane, A. S., & Popper, A.N. (2004b). Noise-induced stress response and hearing loss in goldfish (Carassius auratus). *Journal of Experimental Biology,* 207(Pt 3), 427-435.

Song, J., Mann, D.A., Cott, P. A., Hanna, B.W. & Popper, A.N. (2008). The inner ears of northern Canadian freshwater fishes following exposure to seismic air gun sounds. *Journal of the Acoustical Society of America,* 124(2), 1360-1366.

Song, J., Mathieu, A., Soper, R.F. & Popper, A.N. (2006). Structure of the inner ear of bluefin tuna Thunnus thynnus. *Journal of Fish Biology*, 68, 1767-1781.

South Atlantic Fishery Management Council. (2011). Dolphin Fish. Charleston, SC, South Atlantic Fishery Management Council.

Spargo, B. J. (1999). Environmental Effects of RF Chaff: A Select Panel Report to the Undersecretary of Defense for Environmental Security. Washington, DC, U.S. Department of the Navy, Naval Research Laboratory: 85.

Spargo, B. J. (2007). Chaff end cap and piston bouyancy. M. Collins, Parson.

Sprague, M. W. & Luczkovich, J.J. (2004). Measurement of an individual silver perch Bairdiella chrysoura sound pressure level in a field recording. *Journal of the Acoustical Society of America,* 116(5), 3186-3191.

Speed, C. W., M. G. Meekan, D. Rowat, S. J. Pierce, A. D. Marshall and C. J. A. Bradshaw. (2008). "Scarring patterns and relative mortality rates of Indian Ocean whale sharks." Journal of Fish Biology 72(6): 1488-1503.

Stenseth, N. C., Mysterud, A., Ottersen, G., Hurrell, J.W., Chan, S. & Lima, M. (2002). Ecological effects of climate fluctuations. *Science*, 297, 1292-1296.

Stevens, J. D. (2007). Whale shark (Rhincodon typus) biology and ecology: A review of the primary literature. *Fisheries Research,* 84(1), 4-9.

Stuhmiller, J. H., Phillips, Y. Y. & Richmong, D. R. (1990). The Physics and Mechanisms of Primary Blast Injury R. Zatchuck, D. P. Jenkins, R. F. Bellamy and C. M. Quick (Eds.), *Textbook of Military Medicine. Part I. Warfare, Weapons, and the Casualty* (Vol. 5, pp. 241-270). Washington. D.C.: TMMM Publications.

Swisdak Jr., M. M. & Montaro, P. E. (1992). Airblast and fragmentation hazards produced by underwater explosions. (pp. 35). Silver Springs, Maryland. Prepared by Naval Surface Warfare Center.

Tavolga, W. N. (1974a). Sensory parameters in communication among coral reef fishes. *The Mount Sinai Journal of Medicine,* 41(2), 324-340.

Tavolga, W. N. (1974b). "Signal/noise ratio and the critical band in fishes." *Journal of the Acoustical Society of America,* 55, 1323-1333.

The Hawaii Association for Marine Education and Research Inc. (2005). Manta Rays. 2011.

U.S. Air Force, Headquarters Air Combat Command. (1997). Environmental Effects of Self-Protection Chaff and Flares. Langley Air Force Base, VA, U.S. Air Force: 241.

U.S. Department of the Navy. (1996). Environmental Assessment of the Use of Selected Navy Test Sites for Development Tests and Fleet Training Exercises of the MK-46 and MK 50 Torpedoes, Program Executive Office Undersea Warfare, Program Manager for Undersea Weapons.

U.S. Department of the Navy. (1998). Shock Testing the Seawolf Submarine Final Environmental Impact Statement.

U.S. Department of the Navy. (2001a). Airborne Mine Neutralization System (AMNS) Inert Target Tests: Environmental Assessment and Overseas Environmental Assessment. Panama City, FL, Coastal Systems Station: 83.

U.S. Department of the Navy. (2001b). *Overseas Environmental Assessment (OEA) for Cape Cod TORPEDO EXERCISE (TORPEX) in Fall 2001*. (pp. 62). Arlington, VA: Undersea Weapons Program Office. Prepared by Naval Undersea Warfare Center Division Newport.

U.S. Department of the Navy. (2006). Archival Search Report for Certain Northeast Range Complex Training/Testing Ranges: Small Point Mining Range, Ex-Salmon Site and the Tomahawk Missile Recovery Site at Ralph Odom Survival Training Facility [Final Report]. (Contract No. N62470-02-D-3054, D0 0009, Mod 3, pp. 87). Norfolk, VA: U.S. Department of the Navy.

U.S. Environmental Protection Agency. (2004). Regional Analysis Document for Cooling Water Intake Structures-CWA 316(b), Phase II-Large existing electric generating plants. Cooling Water Intake Structures-CWA 316(b). Washington, DC, EPA.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. (2009). Gulf Sturgeon (Acipenser oxyrinchus desotoi) 5-Year Review: Summary and Evaluation. Panama City, Florida, U.S. Fish and Wildlife Service: 49.

United Nations Environment Programme, Food and Agriculture Organization of the United Nations. (2005). Review of the State of World Marine Fishery Resources. Rome, Italy, FAO Fisheries Department, Fishery Resources Division, Marine Resources Service: 235.

United Nations Environment Programme, Food and Agriculture Organization of the United Nations. (2009). The State of World Fisheries and Aquaculture 2008. Rome, Italy, FAO Fisheries and Aquaculture Department: 196.

The University of Hawaii at Manoa. (2010). Hawaii Undersea Military Munitions Assessment (HUMMA) Final Investigation Report for Hawaii -05 South of Pearl Harbor, Oahu, Hawaii.

van der Oost, R., Beyer, J. & Vermeulen, N.P.E. (2003). Fish bioaccumulation and biomarkers in environmental risk assessment: a review. *Environmental Toxicology and Pharmacology,* 13(2), 57-149.

Vogt, S. (2004). Seabird, Sea Turtle and Marine Mammal Surveys on Farallon de Medinilla for the year 2003, U.S. Naval Forces Marianas: 5.

Wainwright, P. C. & Richard, B. A. (1995). Predicting patterns of prey use from morphology of fishes. Environmental Biology of Fishes, 44, 97-113.

Wardle, C. S. (1986). Fish behaviour and fishing gear. The Behavior of Teleost Fishes. T. J. Pitcher. Baltimore, MD, The Johns Hopkins University Press: 463-495.

Wardle, C. S., Carter, T.J., Urquhart, G.G., Johnstone, A.D.F., Ziolkowski, A. M., Hampson, G. & Mackie, D. (2001). Effects of seismic air guns on marine fish. *Continental Shelf Research,* 21, 1005-1027.

Warrant, E. J. & Locket, N.A. (2004). Vision in the deep sea. *Biological Reviews,* 79(3), 671-712.

Wedemeyer, G. A., B. A. Barton and D. J. McLeay. (1990). Stress and acclimation. In. Methods for Fish Biology. C. B. Schreck and P. B. Moyle. Bethesda, MD, American Fisheries Society: 451-489.

Wegner, N. C., Sepulveda, C. A. & Graham, J.B. (2006). Gill specializations in high-performance pelagic teleosts, with reference to striped marlin (Tetrapturus audax) and wahoo (Acanthocybium solandri). *Bulletin of Marine Science*, 79(3), 747-759.

Whitfield, P. E., Hare, J.A., Davide, A.W., Harter, S.L., Munoz, R.C. & Addison, C.M. (2007). Abundance estimates of the Indo-Pacific lionfish Pterois volitans/miles complex in the Western North Atlantic. *Biological Invasions,* 9(1), 53-64.

Wiley, M. L., J. B. Gaspin and J. F. Goertner.(1981). "Effects of underwater explosions on fish with a dynamical model to predict fishkill." Ocean Science and Engineering 6: 223-284.

Wilson, S.K., Adjeroud, M., Bellwood, D.R., Berumen, M.L., Booth, D., Bozec, Y.M., Chabanet, P., Cheal, A., Cinner, J., Depczynski, M., Feary, D.A., Gagliano, M., Graham, N.A.J., Halford, A.R., Halpern, B.S., Harborne, A.R., Hoey, A.S., Holbrook, S.J., Jones, G.P., Kulbiki, M., Letourneur, Y., De Loma, T.L., McClanahan, T., McCormick, M.I., Meekan, M.G., Mumby, P.J., Munday, P.L., Ohman, M.C., Pratchett, M.S., Riegl, B., Sano, M., Schmitt, R.J. & Syms, C. (2010). Crucial knowledge gaps in current understanding of climate change impacts on coral reef fishes. *Journal of Experimental Biology,* 213(6), 894-900.

Wright, D. G. (1982). A Discussion Paper on the Effects of Explosives on Fish and Marine Mammals in the Waters of the Northwest Territories. Canadian Technical Report of Fisheries and Aquatic Sciences. Winnipeg, Manitoba, Western Region Department of Fisheries and Oceans: 1-16.

Wright, D. G. and G. E. Hopky. (1998). Guidelines for the use of explosives in or near Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences: 2107.

Wright, K. J., Higgs, D. M., Belanger, A.J. & Leis, J.M. (2005). Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces: Pomacentridae). *Marine Biology,* 147, 1425-1434.

Wright, K. J., Higgs, D. M., Belanger, A.J. & Leis, J.M. (2007). Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces: Pomacentridae). *Marine Biology*, 150, 1049-1050.

Wright, K. J., Higgs, D. M., Cato, D.H. & Leis, J.M. (2010). Auditory sensitivity in settlement-stage larvae of coral reef fishes. *Coral Reefs,* 29(1), 235-243.

Wysocki, L. E., Davidson, J. W., Smith, M.E., Frankel, A.S., Ellison, W. T., Mazik, P.M. & Bebak, J. (2007). Effects of aquaculture production noise on hearing, growth, and disease resistance of rainbow trout Oncorhynchus mykiss. *Aquaculture,* 272, 687-697.

Wysocki, L. E., Dittami, J.P. & Ladich, F. (2006). Ship noise and cortisol secretion in European freshwater fishes. *Biological Conservation,* 128, 501-508.

Wysocki, L. E. & Ladich, F. (2005). Hearing in fishes under noise conditions. *Journal of the Association for Research in Otolaryngology,* 6(1), 28-36.

Yelverton, J. T., D. R. Richmond, W. Hicks, K. Saunders and E. R. Fletcher. (1975). The Relationship Between Fish Size and Their Response to Underwater Blast. Defense Nuclear Agency. Washington, D.C., Lovelace Foundation for Medical Education and Research: 40.

Young, G. A. (1991). Concise methods for predicting the effects of underwater explosions on marine life. Silver Spring, Naval Surface Warfare Center.

Zelick, R., Mann, D., & Popper, A.N. (1999). Acoustic communication in fishes and frogs. Comparative Hearing: Fish and Amphibians. R. R. Fay and A. N. Popper. New York, Springer-Verlag: 363-411.

3.10 Terrestrial Species and Habitats

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

3.10 Terrestrial Species and Habitats

TERRESTRIAL SPECIES AND HABITATS SYNOPSIS

The United States Department of the Navy considered all potential stressors, and the following were analyzed for terrestrial species and habitats:

- Acoustic (explosives noise, weapons firing noise, and aircraft noise)
- Physical (disturbance or strikes by aircraft and aerial targets, military expended materials including explosive munitions fragments, ground disturbance, and wildfires)
- Secondary stressors (invasive species introductions, water and air quality)

Preferred Alternative (Alternative 1)

- Acoustic: Pursuant to the Endangered Species Act (ESA), explosives noise and weapons firing noise may affect and are likely to adversely affect the Micronesian megapode and the Mariana fruit bat on Farallon de Medinilla (FDM), and would not affect the Guam rail, Guam Micronesian kingfisher, Mariana common moorhen, Mariana crow, Mariana swiftlet, nightingale reed-warbler, and the Rota bridled white-eye. Aircraft noise may affect but is not likely to adversely affect the Mariana common moorhen, Mariana fruit bat, Mariana swiftlet, Mariana crow, and the Micronesian megapode, and would have no affect the Guam rail, Guam Micronesian kingfisher, nightingale reed-warbler, and the Rota bridled white-eye. Pursuant to the ESA, acoustic stressors would have no effect on the three ESA-listed plant species within the Study Area (*Serianthes nelsonii*, *Nesogenes rotensis*, and *Osmoxylon mariannense*).
- Physical: Pursuant to the ESA, the use of aircraft and aerial targets may affect but is not likely to adversely affect the Mariana fruit bat and Mariana common moorhen; and would have no effect on the Guam rail, Guam Micronesian kingfisher, Mariana crow, Mariana swiftlet, Micronesian megapode, nightingale reed-warbler, and the Rota bridled white-eye. The use of military expended materials may affect and is likely to adversely affect the Micronesian megapode, may affect but is not likely to adversely affect the Mariana fruit bat, and would have no effect on the Guam rail, Guam Micronesian kingfisher, Mariana common moorhen, Mariana crow, Mariana swiftlet, nightingale reed-warbler, and the Rota bridled white-eye. Ground disturbance may affect and is likely to adversely affect the Micronesian megapode, may affect but is not likely to adversely affect the Mariana swiftlet and nightingale reed-warbler, and would have no effect on the Guam rail, Guam Micronesian kingfisher, Mariana common moorhen, Mariana crow, Mariana fruit bat, and the Rota bridled white-eye. Wildfires may affect and are likely to adversely affect the Micronesian megapode, and would have no affect on the Guam rail, Guam Micronesian kingfisher, Mariana common moorhen, Mariana crow, Mariana fruit bat, Mariana swiftlet, nightingale reed-warbler, and the Rota bridled white-eye.
- Pursuant to the ESA, physical stressors would have no effect on the three ESA-listed plant species within the Study Area (*Serianthes nelsonii, Nesogenes rotensis,* and *Osmoxylon mariannense*) or the two endemic ESA-listed plant species on Rota (*Nesogenes rotensis*, and *Osmoxylon mariannense*).
- The U.S. Fish and Wildlife Service (USFWS) has designated Critical Habitats on Guam for the Mariana fruit bat, Mariana crow, and Guam Micronesian kingfisher. The USFWS has designated Critical Habitats on Rota for the Rota bridled white-eye,

TERRESTRIAL SPECIES AND HABITATS SYNOPSIS (continued)

- Pursuant to the ESA, secondary stressors would have no effect on ESA-listed species. The Navy, in cooperation with the USFWS and other resource agencies, engages in policies and practices that reduce the potential for the transport of invasive species to the Mariana Islands and between military training areas.
- Acoustic and physical stressors have the potential to injure and kill terrestrial bird species that are not ESA listed, particularly those that roost and breed on FDM. Pursuant to the Migratory Bird Treaty Act (MBTA) and 50 Code of Federal Regulations Part 21.15, these impacts will not cause significant adverse effects to populations of bird species not ESA-listed and otherwise protected under the MBTA.

3.10.1 Introduction

This section addresses terrestrial species and habitats for military activities that occur on land training areas within the Mariana Islands Training and Testing (MITT) Study Area (Study Area). Specifically, this section addresses vegetation communities, wildlife communities, and Endangered Species Act (ESA) listed species (including species considered candidates for ESA listing) found on military owned and leased lands on Guam, Tinian, and Farallon de Medinilla (FDM). This section also addresses potential impacts on lands used by special agreement within the Study Area, such as lands on Rota and Saipan.

3.10.1.1 Endangered Species Act

The ESA of 1973 established protection over and conservation of threatened and endangered species and the ecosystems upon which they depend. An “endangered” species is a species in danger of extinction throughout all or a significant portion of its range, while a “threatened” species is one that is likely to become endangered within the near future throughout all or in a significant portion of its range. The United States (U.S.) Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service jointly administer the ESA and are also responsible for the listing of species (i.e., the labeling of a species as either threatened or endangered). The USFWS has primary management responsibility for terrestrial and freshwater species, while the National Marine Fisheries Service has primary management responsibility for marine species and anadromous fish species (species that migrate from saltwater to freshwater to spawn). The ESA allows the designation of geographic areas as Critical Habitat for threatened or endangered species.

The ESA requires federal agencies to conserve listed species and consult with the USFWS and/or National Marine Fisheries Service to ensure that proposed actions that may affect listed species or Critical Habitat are consistent with the requirements of the ESA. The ESA specifically requires agencies not to “take” or “jeopardize” the continued existence of any endangered or threatened species, nor to destroy or adversely modify designated critical habitat. Under Section 3 of the ESA, “take” means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect. “Jeopardize,” a term used in Section 7 of the ESA, is defined in Title 50, Section 402.30 of the Code of Federal Regulations (50 C.F.R. 402.30) as engaging in any action that would be expected to appreciably reduce the likelihood of the survival and recovery of a listed species by reducing its reproduction, numbers, or distribution.

Section 7 formal consultation with the USFWS is necessary because some training activities proposed by the military may potentially affect federally protected species, habitats, and recovery efforts. The U.S.

Department of the Navy (Navy) will enter into Section 7 formal consultation, a process that begins with the Navy's submission of a Section 7 ESA consultation package to the USFWS Pacific Islands Fish and Wildlife Office.

3.10.1.1.1 Endangered Species Act Listed Species and Designated Critical Habitat

The ESA-listed terrestrial species known to occur within the Study Area include three plant species, six bird species, and one mammal. These species are listed in Table 3.10-1. The Guam Micronesian kingfisher (*Todiramphus cinnamomina cinnamomina*) is extirpated from Guam habitats, and only exists in captive breeding programs. The Guam rail (*Rallus owstoni)* is also extirpated from Guam. A nonessential experimental population exists on Rota, and Guam rails have been introduced on Cocos Island (off the coast of Guam). The Mariana crow (*Corvus kubaryi*) is now considered extirpated from Guam, but still occurs on Rota.

Two ESA-listed sea turtle species that nest on Department of Defense (DoD)-owned and leased lands on Guam and Tinian are included in this Environmental Impact Statement (EIS)/Overseas EIS (OEIS) in Section 3.5 (Sea Turtles). Three species of ESA-listed seabirds are addressed in Section 3.6 (Marine Birds).

Critical habitat is a term defined and used in the ESA and includes specific geographic areas that are essential for the conservation of a threatened or endangered species and that may require special management and protection. Critical habitat may include an area that is not currently occupied by the species but that will be needed for its recovery. Critical habitat is designated on Guam and Rota for the Mariana fruit bat and Mariana crow (376 acres (ac.) [152 hectares {ha}]). The Micronesian kingfisher has critical habitat designated on Guam (376 ac. [152 ha]), and the Rota bridled white-eye has critical habitat designated on Rota (2,594 ac. [1,050 ha]). The Guam critical habitat designations are confined to the Guam National Wildlife Refuge Ritidian Unit and do not overlay or coincide with military training activities. Similarly, the military does not train within critical habitat designations on Rota. Figure 3.10-1 and Figure 3.10-2 show the critical habitat designations.

Table 3.10-1: Endangered Species Act-Listed Terrestrial Species in the Mariana Islands Training and Testing Study Area

Species Name and Regulatory Status			Presence in Study Area	
Local Name[1]	**Scientific Name**	**Endangered Species Act Status**	**Preferred Habitat**	**DoD Training Area[2]**
Plants				
Hayun lagu/ Tronkon guafi (Fire tree)	*Serianthes nelsonii*	Endangered	Limestone forests on Guam and Rota	Andersen AFB
-	*Osmoxylon mariannense*	Endangered	Limestone forests of Rota	-
-	*Nesogenes rotensis*	Endangered	Coastal strand habitats	-
Birds				
Yayaguak (Mariana swiftlet)	*Aerodramus bartschi*	Endangered	Nests in caves; forages in savanna and ravine forest	NBG Munitions Site
Aga (Mariana crow)	*Corvus kubaryi*	Endangered	Limestone forests of Guam and Rota	Extirpated[3]
Pulattat (Mariana common moorhen)	*Gallinula chloropus guami*	Endangered	Freshwater aquatic habitat types (lake, pond, and springs)	NBG Apra Harbor, NBG Munitions Site, Tinian MLA
Sihek (Guam Micronesian kingfisher)	*Todiramphus cinnamomina cinnamomina*	Endangered	Limestone forests on Guam	Extirpated[3]
Sasangat (Micronesian megapode)	*Megapodius laperouse laperouse*	Endangered	Limestone forests and coconut groves	Saipan Marpi Maneuver Area, Tinian MLA, FDM. Formerly occupied Andersen AFB, NBG Telecommunications Site, NBG Munitions Site, and NBG Apra Harbor.
Ko'ko' (Guam rail)	*Rallus owstoni*	Endangered	Secondary and open habitats in limestone forests	Extirpated[3]
Ga'ga' karisu (Nightingale reed-warbler)	*Acrocephalus luscinia*	Endangered	Tangantangan thickets and wetlands	Saipan Marpi Maneuver Area
Nossa' Luta (Rota bridled white-eye)	*Zosterops rotensis*	Endangered	Limestone forests of Rota	-
Mammals				
Fanihi (Mariana fruit bat)	*Pteropus mariannus mariannus*	Threatened	Limestone and Ravine forests. Guam, Rota, Saipan, Tinian, FDM	Andersen AFB, NBG Telecommunications Site, NBG Munitions Site, Tinian MLA, FDM

[1] Scientific, Chamorro, and English names for plants and animals are provided in the table. Chamorro names will be used for plants, with first mention of scientific name (not all plants within the Study Area have commonly used English names). English names will be used for animals, with scientific and Chamorro names at first mention. Some species do not have an English name or a known Chamorro name. In these instances, only the scientific name is used. There are no English common names or known Chamorro names for *Osmoxylon mariannense* or *Nesogenes rotensis.*
[2] Includes DoD-owned and leased lands.
[3] Indicates that the species is extirpated. The Guam rail, Guam Micronesian kingfisher, and Mariana crow are extirpated from the wild on Guam. An nonessential experimental population was established for the Guam rail on Rota and Cocos Island (off of Guam).
[4] Indicates that the species exists only in captivity
Notes: DoD = Department of Defense, MLA = Military Lease Area, FDM = Farallon de Medinilla, NBG = Naval Base Guam, AFB = Air Force Base

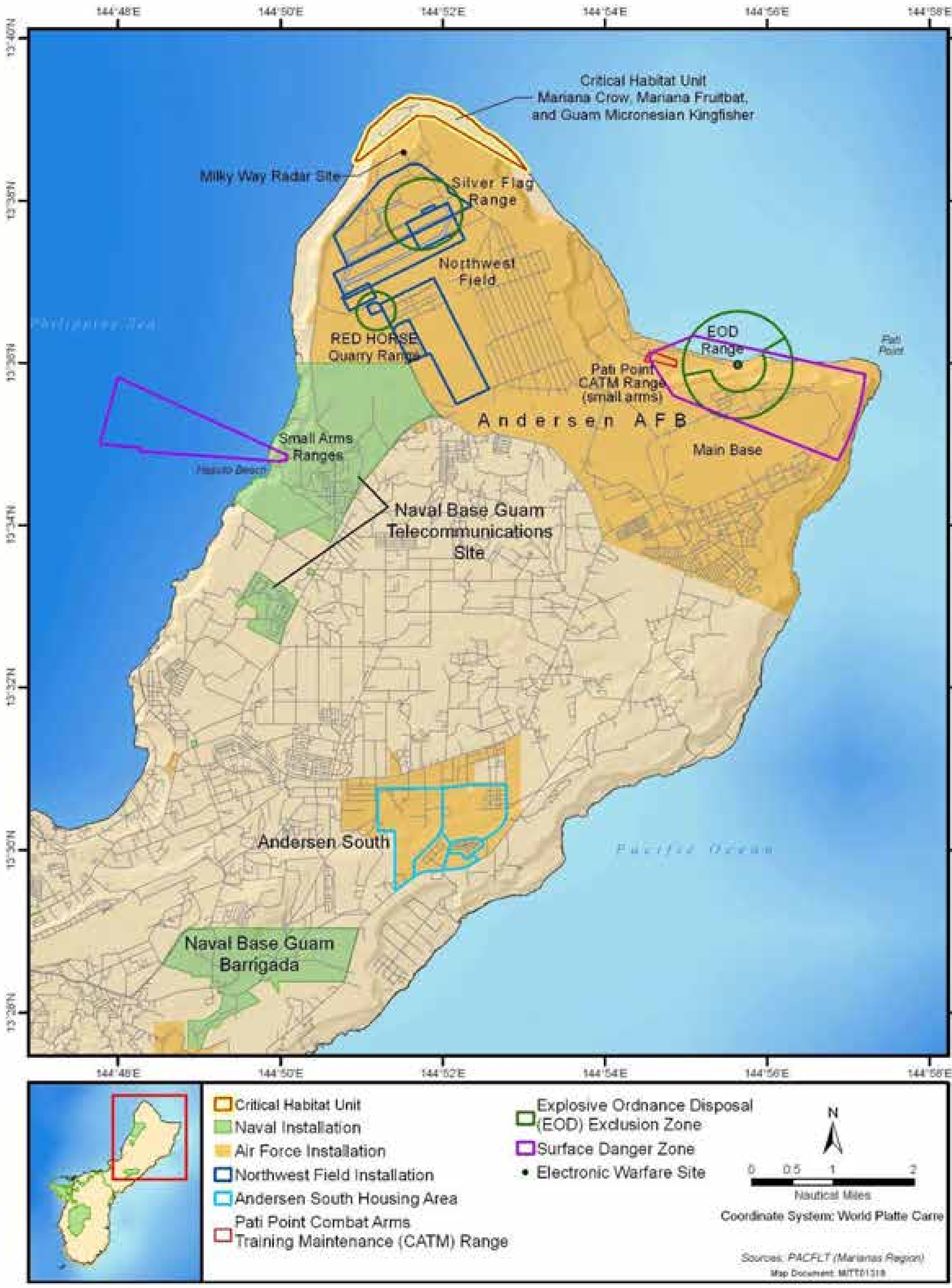


Figure 3.10-1: Critical Habitat Designations on Guam

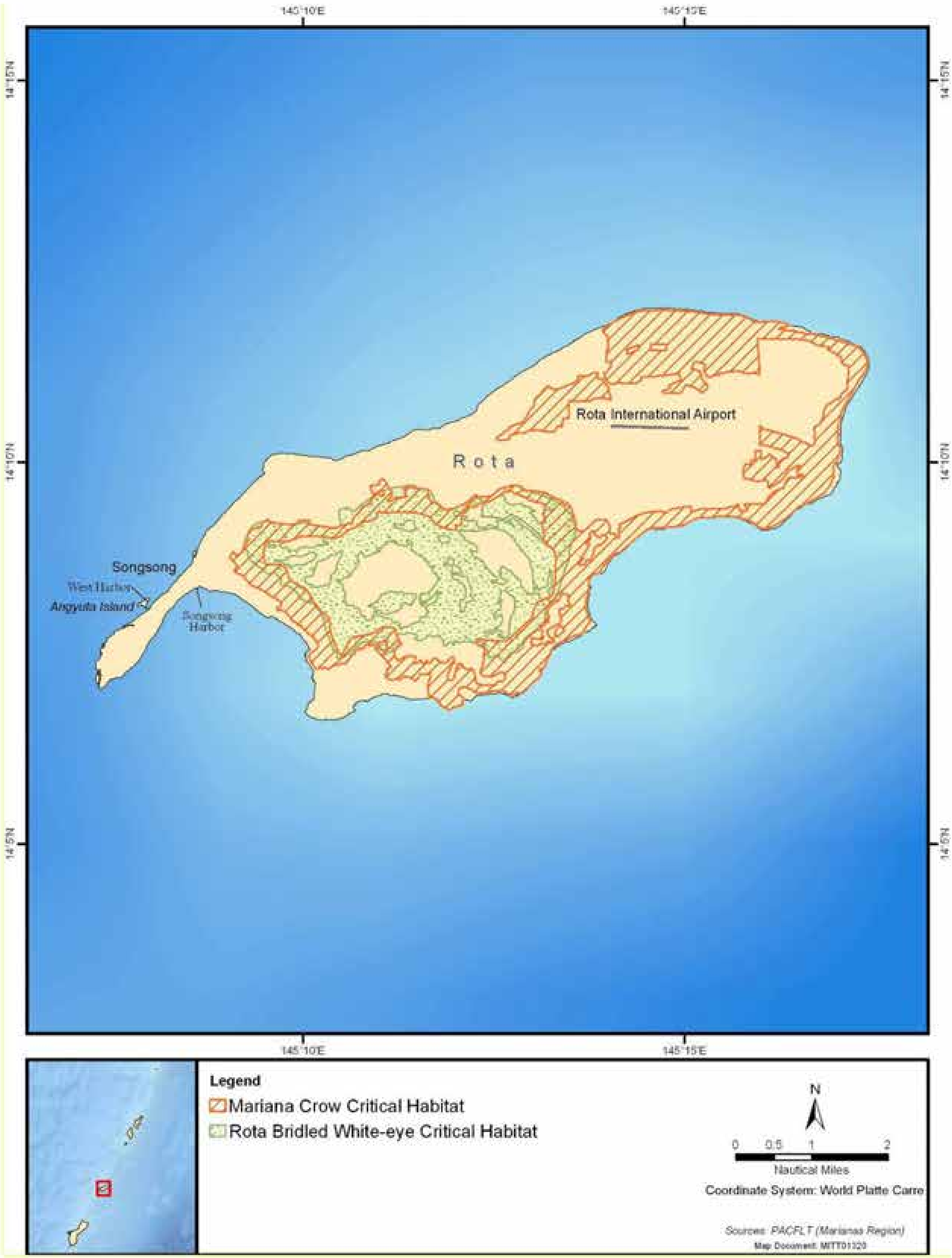


Figure 3.10-2: Critical Habitat Designations on Rota

3.10.1.1.2 Endangered Species Act Candidate Species

A candidate species is the subject of either a petition to list or status review, and for which the USFWS has determined that listing may be warranted (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998). Candidate species receive no statutory protection under the ESA; however, the USFWS encourages the formation of partnerships to conserve these species because they are, by definition, species that may warrant future protection under the ESA. In 2011, the USFWS completed a multi-year listing work plan that facilitates the systematic review of more than 250 species to determine if their listing is warranted under the ESA. The work plan and supplemental agreements were developed in coordination with two plaintiff groups (Wild Earth Guardians and the Center for Biological Diversity). These agreements were approved by the U.S. District Court for the District of Columbia in September 2011. As part of the agreement, the USFWS is assessing seven candidate species that may occur in the Mariana Islands. These species include two butterfly species, four partulid snail species, and one mammalian species. These species are listed in Table 3.10-2 and described in more detail below.

Table 3.10-2: Species Considered as Candidates for Endangered Species Act Listing

<table>
<tr><th colspan="2">Species Name</th><th colspan="2">Presence in Study Area</th></tr>
<tr><th>Local Name[1]</th><th>Scientific Name</th><th>Habitat</th><th>DoD Training Area[3]</th></tr>
<tr><td colspan="4">Butterfly Species[2]</td></tr>
<tr><td>Mariana eight-spot butterfly</td><td>Hypolimnas octocula marianensis</td><td>Limestone forests along clifflines, associated with two host plant species: Procris pedunculata and Elatostema calcareum. Occurs on Guam and Rota.</td><td>Andersen AFB, Tinian Military Lease Area</td></tr>
<tr><td>Mariana wandering butterfly</td><td>Vagrans egistina</td><td>Limestone forests along clifflines, associated with the host plant species Maytenus thompsoni. No longer occurs on Guam, but is known to occur on Rota.</td><td>Extirpated[4]</td></tr>
<tr><td colspan="4">Partulid Snail Species[2]</td></tr>
<tr><td>Humped tree snail</td><td>Partula gibba</td><td rowspan="4">Sub-canopy vegetation in lower strata of intact limestone forests forested and river corridors. Humped tree snails occur on Guam, Rota, Aguiguan, Tinian, Saipan, Anatahan, Sarigan, Alamagan, and Pagan. Guam tree snails are restricted to Guam. Fragile tree snails are found on Guam and Rota. Langford tree snails are endemic to Aguiguan (they do not occur on other islands in the Mariana Archipelago).</td><td>Andersen AFB, NBG Telecommunications Site, NBG Munitions Site, Tinian MLA (potential)</td></tr>
<tr><td>Guam tree snail</td><td>Partula radiolata</td><td rowspan="2">Andersen AFB, NBG Telecommunications Site, NBG Munitions Site</td></tr>
<tr><td>Fragile tree snail</td><td>Samoana fragilis</td></tr>
<tr><td>Langford tree snail</td><td>Partula langfordi</td><td>-</td></tr>
<tr><td colspan="4">Mammalian Species</td></tr>
<tr><td>Pacific sheath-tailed bat</td><td>Emballonura semicaudata</td><td>Inhabits caves, prefers limestone forests as foraging habitat. Restricted to Aguiguan.</td><td>Extirpated[4]</td></tr>
</table>

[1] Scientific, Chamorro, and English names for candidate species are provided in the table. Chamorro names will be used for plants, with first mention of scientific name (not all plants within the Study Area have commonly used English names). English names will be used for animals, with scientific and Chamorro names at first mention. Some species discussed in the text do not have an English name or a known Chamorro name. In these instances, only the scientific name is used.

[2] The Chamorro name, "ababang," is used for both butterfly species listed in this table. The Chamorro name, "akaleha," is used for all three tree snail species. Therefore, the English common name is used for the butterfly and snail species.

[3] Includes DoD-owned and leased lands.

[4] Indicates that the species is considered extirpated from the DoD training area. Mariana wandering butterfly is extirpated from Guam and is currently restricted to Rota. Pacific sheath-tailed bats are extirpated from Guam and other islands and are restricted to Aguiguan.

Notes: DoD = Department of Defense, NBG = Naval Base Guam, AFB = Air Force Base, ssp. = subspecies

3.10.1.2 Migratory Bird Treaty Act and 50 Code of Federal Regulations Part 21.15 Requirements

Terrestrial birds in the Study Area include those listed under the Migratory Bird Treaty Act (MBTA) of 1918 (16 United States Code 703-712; Ch. 128; 13 July 1918; 40 Stat. 755 as amended) (U.S. Department of Defense and U.S. Fish and Wildlife Service 2006). The MBTA established federal responsibilities for the protection of nearly all species of birds, eggs, and nests. Further, the MBTA affords protections to terrestrial bird species within the Study Area that are not listed under the ESA.

Through the National Defense Authorization Act, Congress determined that allowing incidental take of migratory birds as a result of military readiness activities is consistent with the MBTA. The Final Rule was published in the Federal Register (FR) on 28 February 2007 (FR Volume 72, No. 29, 28 February 2007), and may be found at 50 C.F.R. Part 21.15. Congress defined military readiness activities as all training and operations of the Armed Forces that relate to combat and the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for the proper operation and suitability for combat use. The measure directs the Armed Forces to assess the effects of military readiness activities on migratory birds, in accordance with National Environmental Policy Act (NEPA). It also requires the Armed Forces to develop and implement appropriate conservation measures if a proposed action may have a significant adverse effect on a migratory bird population. The Navy has determined that no activity described in this EIS/OEIS would represent a significant adverse effect on any terrestrial bird population.

3.10.1.2.1 United States Fish and Wildlife Service Birds of Conservation Concern

Birds of Conservation Concern are species, subspecies, and populations of migratory and non-migratory birds that the USFWS determines through policy documents to be the highest priority for conservation actions (U.S. Fish and Wildlife Service 2008a). The purpose of the Birds of Conservation Concern category is to prevent or remove the need for additional ESA bird listings by implementing proactive management and conservation actions needed to conserve these species. The USFWS maintains a list of Birds of Conservation Concern for U.S. Pacific Islands (U.S. Fish and Wildlife Service 2008a).

Of the 21 terrestrial bird species considered as Birds of Conservation Concern for U.S. Pacific Islands, four species are known to breed on islands within the Study Area and are listed in Table 3.10-3. Four of the five species breed on DoD-owned or leased lands within the Study Area (Rufous fantail [*Rhipidura rufifrons*], Micronesian starling [*Aplonis opaca*], and Tinian monarch [*Monarcha takatsukasae*]). The golden white-eye (*Cleptornis marchei*) breeds on Saipan and Aguiguan only. None of these species are believed to breed on FDM.

Table 3.10-3: United States Fish and Wildlife Service Birds of Conservation Concern and Breeding Terrestrial Birds within the Study Area

Common Name	Scientific Name	Breeding location on DoD Owned or Leased Property	Other Islands within the Study Area[1]
Chichirika/Naabak (Rufous fantail)	***Rhipidura rufifrons***	**Tinian MLA**	**Rota, Saipan, Aguiguan**
Sali (Micronesian starling)	***Aplonis opaca***	**Andersen AFB, Naval Base Guam Telecommunications Site, Tinian MLA**	**Rota, Saipan, Aguiguan, Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, Maug**
Chichurikan Tinian (Tinian monarch)	***Monarcha takatsukasae***	**Tinian MLA**	**-**
Canario (Golden white-eye)	***Cleptornis marchei***	**-**	**Saipan, Aguiguan**
Puluman (White-throated ground dove)	*Gallicolumba xanthonura*	Tinian MLA	Rota, Aguiguan, Saipan, Anatahan
Totot (Mariana fruit dove)	*Ptilinopus roseicapilla*	Tinian MLA	Rota, Aguiguan, Saipan
Sihek Collared kingfisher	*Todiramphus chloris*	Tinian MLA	Rota, Aguiguan, Guguan, Sarigan, Alamagan, Pagan, Agrihan, Asuncion, Maug
Egigi (Micronesian honeyeater)	*Myzomela rubratra*	Tinian MLA	Rota, Aguiguan, Saipan, Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, Maug

[1] These islands are located within the Study Area; however, these islands do not include Navy owned or leased lands. Limited training activities may occur on Rota and Saipan through special use agreement with local authorities.

Notes: (1) Birds listed in the above table are native terrestrial birds not currently protected under the Endangered Species Act. The rufous fantail, Micronesian starling, Tinian monarch, bridled white-eye, and golden white-eye are considered by the USFWS as Birds of Conservation Concern, and highlighted in bold text. The island collared dove, black francolin, black drongo, and Eurasian tree sparrow also breeds within the Study Area; however, these species are not listed in the table because they are introduced species. ESA-listed terrestrial bird species are listed under Table 3.10-1. (2) DoD = Department of Defense, Tinian MLA = Tinian Military Lease Area, Andersen AFB = Andersen Air Force Base

Sources: Lusk et al. (2000), Wiles (2005), U.S. Department of the Navy (2012, 2013), U.S. Fish and Wildlife Service (2008)

3.10.1.3 General Taxonomic Groups

The ecological profile of the Mariana Islands is complex, with many factors interacting with each other, such as geology, human environmental history, climate and weather events, and invasive species. One way to provide a "snapshot" of the ecological profile of the Mariana Islands is to consider the faunal assemblage. Accordingly, Table 3.10-4 lists major vertebrate taxonomic groups (amphibians, reptiles, birds, and mammals) known to occur within the Mariana Islands.

Some species represented in Table 3.10-4 have special regulatory status and are discussed in more detail in Section 3.10.1.1.1 (Endangered Species Act Listed Species and Designated Critical Habitat). Species that do not have special regulatory status are discussed more generally in Section 3.10.2.1 (Vegetation Communities) and Section 3.10.2.2 (Wildlife Communities).

Table 3.10-4: Major Vertebrate Taxonomic Groups

Major Taxonomic Group		Presence in Study Area
Common Name (Species Grouping)[1]	**Description**	**DoD Training Area**
Amphibians		
Frogs and Toads (Family Ranidae, Family Microhylidae, Family Leptodactylidae, Family Eleutherodactylidae, Family Hylidae, and Family Bufonidae)	The marine toad, an introduced species established on Guam and the CNMI, inhabits upland and wetland sites. Ten species of frogs are known to occur on Guam and the CNMI, all introduced.	Marine toads occur on Guam, Tinian, and Saipan. Other amphibians occur on Guam.
Reptiles		
Freshwater turtles (Family Emydidae)	Uncommon introduced turtles living in freshwater streams and wetlands, such as the red-eared slider. Likely introduced through the commercial pet trade and Asian food markets.	Occurring at Naval Base Guam, Naval Base Guam Munitions Site
Geckos, Anoles, Skinks (Family Gekkonidae, Polychridae, Scincidae)	On Guam, declining native populations with increasing introduced species serving as an additional food source for brown treesnakes. Introduced species in the Marianas are documented to displace native species.	Occurring on all DoD owned and leased lands
Monitor lizards (Family Varnidae)	A native species considered to be an early introduction (approximately 1,600 years ago), this large lizard species inhabits upland and wetland sites.	Occurring on all DoD owned and leased lands, except for FDM
Blind snakes (Family Typhlopidae)	Recent introduction to Mariana Islands, ground burrowing snakes with vestigial (remnant) eyes.	Occurring on all DoD owned and leased lands, except for FDM
Colubrid snakes (Family colubridae)	Represented by the invasive brown treesnake.	Established population on Guam
Birds[2]		
Megapodes (Family Megapodiidae)	Represented by the Micronesian megapode within the Mariana Islands. Extirpated from Guam.	Tinian MLA, Saipan Marpi Maneuver Area, FDM
Moorhens and Rails (Family Rallidae)	Represented by the Mariana common moorhen in the Marianas and Guam rails (Guam rails persist in captivity; a nonessential experimental population was established on Rota, and a Safe Harbor Agreement is in effect on Cocos Island).	Mariana common moorhens are found on all DoD-owned and leased lands, except for FDM.
Quails and Pheasants (Family Phasianidae)	Introduced species represented by the black francolin and the uncommon blue-breasted quail.	Occurring on all DoD-owned lands on Guam. Blue-breasted quail only found on the southern savannas of Guam, possibly including Naval Base Guam Munitions Site.
Pigeons and doves (Family Columbidae)	Represented by four species: the endemic Mariana fruit dove and white-throated ground dove, and the introduced island collared-dove and rock dove.	Native species extirpated on Guam, but native fruit doves and ground doves found on Tinian MLA, Saipan Marpi Maneuver Area, and Rota.
Swifts (Family Apodidae)	Represented by one cave-dwelling species (Mariana swiftlet). Extirpated from Tinian and Rota.	Occurs on Naval Base Guam Munitions Site

Table 3.10-4: Major Vertebrate Taxonomic Groups (continued)

Major Taxonomic Group		Presence in Study Area
Common Name (Species Grouping)[1]	**Description**	**DoD Training Area**
Kingfishers (Family Alcedinidae)	Species group extirpated from Guam. Guam Micronesian kingfisher persists in captivity; Collared Kingfisher present on Rota, Tinian, and Saipan.	Collared kingfisher present on Tinian MLA and Saipan Marpi Maneuver Area.
Drongos (Family Dicruridae)	Represented by the introduced black drongo	Occurring on all DoD lands on Guam.
Crows and jays (Family Corvidae)	Represented by the Mariana crow, declining numbers on Rota.	The last known crow on Guam was detected on Andersen Air Force Base in August 2011 and is considered extirpated from Guam.
Old World flycatchers and warblers (Family Muscicapidae)	On Guam, represented by four native species, all extirpated from Guam. The Guam flycatcher is extinct. This species group is found on Rota, Tinian, and Saipan.	Tinian monarchs are found within Tinian MLA, nightingale reed-warblers are found on Saipan Marpi Maneuver Area.
Starlings (Family Sturnidae)	Represented by the native Micronesian starling.	Andersen Air Force Base, Tinian MLA, and FDM
Honeyeaters (Family Meliphagidae)	Represented by the Micronesian honeyeater; extirpated from Guam	Present on Tinian MLA and Saipan
White-eyes (Family Zosteropidae)	Represented by the bridled white-eye, golden white-eye; extirpated from Guam, but occurs within the CNMI. Golden white-eyes only occur on Aguiguan and Saipan. Rota bridled white-eye occurs on Rota.	Golden white-eyes found on Saipan Marpi Maneuver Area. Bridled white eyes occur on Rota, Tinian MLA, and Saipan Marpi Maneuver Area.
Weavers (Family Passeridae)	Represented by the Eurasian tree sparrow.	Occurring on all DoD-owned and leased lands
Mammals		
Rats, mice, shrews (Family Muridae and Soricidae)	Introduced species of musk shrews, Polynesian rats, roof rats, Norway rats, and house mice.	Occurring on all DoD-owned and leased lands. No shrews or house mouse on FDM.
Bats (Family Pteropodidae and Emballonuridae)	The Mariana fruit bat and Pacific sheath-tailed bat. Sheath-tailed bats are restricted to Aguiguan Island in the CNMI and have been extirpated from Guam.	Mariana fruit bats on Andersen Air Force Base, Navy Communications Site, Naval Base Guam Munitions Site, Tinian MLA, FDM
Dogs and cats (Family Canidae and Felidae)	Introduced feral, semi-feral, and domesticated dogs and cats.	Occurring on all DoD-owned and leased lands, except for FDM
Ungulates (Families Suidae, Cervidae, Bovidae)	Feral pigs, Philippine deer, Asiatic water buffalo	Water buffalo only occur on Naval Base Guam Munitions Site. Deer and pig potentially occur on all DoD-owned and leased lands, except for FDM.

[1] Various seabird and shorebird bird groups associated with marine and coastal environments are discussed in Section 3.6 (Marine Birds).

[2] Source: Wiles (1998), U.S. Department of the Navy (2012); Pregill and Steadman (2009).

Notes: DoD = Department of Defense, FDM = Farallon de Medinilla, MLA = Military Lease Area, CNMI = Commonwealth of the Northern Mariana Islands

3.10.1.4 General Threats to Terrestrial Species and Habitats within the Mariana Islands

There are numerous threats to native species and habitats in the Mariana Islands. Major threats to native species include (but are not limited to): (1) introduced and invasive plants and animals, and (2) loss and/or degradation of key habitat types. These threats are summarized below.

3.10.1.4.1 Introduced and Invasive Species

Terrestrial species may be classified as either native or introduced depending on their origin and the chronology of their introduction to Guam and other islands within the Study Area. A native species may be further considered as endemic to a particular island or the Mariana archipelago if the species is not found outside the area. An introduced species will demonstrate some degree of invasiveness, which is a measure of severity on native ecosystems (Davis 2009; Thompson and Davis 2011). Increasing populations, economic cycles of growth and retraction, and strategic location contributed to the escalating rate of intentional and accidental introductions of alien species in the Mariana Islands (Commonwealth of the Northern Mariana Islands Division of Fish and Wildlife 2005; Guam Division of Aquatic and Wildlife Resources 2006).

Although there are many introduced plant and animal species important to the degradation of habitats and modification of ecological processes, the most notorious species introduced to Guam is the brown treesnake (*Boiga irregularis*), discussed in more detail in Section 3.10.2.2 (Wildlife Communities). The brown treesnake was accidentally introduced to Guam from the Admiralty Islands (a group of islands of northern Papua New Guinea) following World War II (Rodda et al. 1997). Snakes that survived the transport escaped into terrestrial habitats of Guam, expanding outward from Apra Harbor. The snakes established on Guam and, by 2011, only 2 of 12 native forest bird species remain (the Micronesian starling and the Mariana swiftlet) (Fritts and Leasman-Tanner 2001). Further, the snake population on Guam appears to be sustained by introduced skinks and geckos, which was a food source for the brown treesnake within its native range (Christy et al. 2007a). Introduction, establishment, and subsequent removal of ecological prey species could occur on other Mariana Islands or other suitable areas in the Pacific if brown treesnakes survive transport to new locations.

The potential for training activities to degrade island habitats through the accidental introduction of potentially invasive species is addressed in Section 3.10.3.3.1 (Impacts from Invasive Species Introductions). This section identifies the potential introduction pathways associated with training activities described in this EIS/OEIS.

3.10.1.4.2 Loss and/or Degradation of Key Habitat Types

Loss of key habitats is a problem that will have long-term effects on terrestrial habitats and species. Major factors exacerbating habitat loss are ungulates (hoofed animals), development, introduction of invasive plant and animal species, natural events (such as typhoons), and the ecological modification of factors that affect recovery from natural events (Commonwealth of the Northern Mariana Islands Division of Fish and Wildlife 2005; Guam Division of Aquatic and Wildlife Resources 2006).

Probably the most difficult and labor-intensive factor to control is damage by invasive species, such as brown treesnakes and ungulates. One of the potential cascading effects of the introduced brown treesnake is the loss and/or reduction of seed-dispersing birds and bats, which in turn may contribute to the loss of native forest. Feral pigs, deer, and water buffalo alter the forest composition by browsing on or disturbing vegetation. Many native flora are preferred by ungulates because native flora do not possess the chemical and physical defenses found in many introduced plants. This form of artificial selection allows invasive plant species to dominate natural habitats, which further modifies native habitats (Davis 2009; Guam Division of Aquatic and Wildlife Resources 2006; Thompson and Davis 2011).

3.10.2 AFFECTED ENVIRONMENT

3.10.2.1 Vegetation Communities

This section describes vegetation communities found on DoD owned or leased lands on Guam and the Commonwealth of the Northern Mariana Islands (CNMI). The composition and structure of these plant communities are influenced by a variety of factors, such as current and past disturbances, substrates, and precipitation. Many native plants discussed in this section are culturally important as medicinal plants, spiritual significance, or traditional food sources.[1]

3.10.2.1.1 Guam Department of Defense Lands

The floristic complexity of Guam's plant communities and the absence of distinct associations of species have led ecologists to emphasize the underlying soil and the relative degree of disturbance when classifying plant communities, rather than solely their floristic composition. Navy natural resource specialists grouped vegetation types based on works by Fosberg (1960) and Stone (1970).

These vegetation types are grouped into the following five general plant communities: (1) limestone, (2) ravine, (3) wetland, (4) strand, and (5) savanna (U.S. Department of the Navy 2013a). The five general plant communities occurring on Guam are discussed in greater detail in the following paragraphs. Distinct communities within the general plant communities are identified where possible based on data from previous field surveys. Photos of representative community types are shown in Figure 3.10-3.

Limestone Communities. Limestone communities are situated on elevated limestone terraces, plateaus, and slopes. Forest community structure and composition are primarily influenced by the high winds of typhoons. Depending on the relative age of the vegetation within the community, limestone forest can be further divided into primary and secondary forests, with primary forests being the historic limestone forest and the secondary being a successional form after primary forests were impacted by catastrophic forces such as typhoons and intensive military actions (e.g., bombing). Limestone plant communities are diverse and highly variable, containing both native and nonnative woody plants, ferns, and herbaceous plants adapted to excessively drained, shallow limestone soil. The endangered *Serianthes* tree occurs in limestone forests and is restricted to the forested portion of Northwest Field above Ritidian Point (see Table 3.10-1). In their least disturbed state, these plant communities have a stratified canopy consisting of scattered, large, emergent trees, such as dukduk (*Artocarpus mariannensis*) and nunu (*Ficus prolixa*), with a maximum height of 60 to 70 feet (ft.) (18.3 to 21.3 meters [m]). Other dominant species composing both the upper canopy and mid-canopy layers include mapunao (*Aglaia mariannensis*), langiti (*Ochrosia marianensis*), ahgao (*Premna obtusifolia*), yoga (*Elaeocarpus joga*), ifit (*Intsia bijuga*), umumu (*Pisonia grandis*), pahong (*Pandanus dubius*), and kafo (*Pandanus tectorius*) (U.S. Department of the Navy 2013a). Mid-canopy layers can be 30 to 45 ft. (9.1 to 13.7 m) tall. Smaller individuals of the above species and species such as paipai (*Guamia mariannae*), fadang (*Cycas micronesica*), and lada (*Morinda citrifolia*) are often present as an understory layer. The floristic composition of a limestone forest can be variable depending on location and the history of disturbance (U.S. Department of the Navy 2013a).

[1] Species of flora and fauna continue to have integral roles in contemporary Chamorro culture. In acknowledgement, this EIS/OEIS will use Chamorro names for plants, with first mention of scientific name (not all plants within the Study Area have commonly used English names). English names will be used for animals, with scientific and Chamorro names at first mention. Some species discussed in the text do not have an English name or a known Chamorro name. In these instances, only the scientific name is used.

Notes: 1. Upper left panel: large dukduk (*Artocarpus mariannensis*) in mature limestone forest, Naval Base Guam Telecommunications Site (March 2011). 2. Upper right panel: coastal strand community located at Mergagan Point, near Andersen AFB (April 2010). 3. Lower left panel: karisu (*Phragmites karka)* and open water near Laguas River bridge (April 2011). 4. Lower right panel: savanna communities and erosion scars west of the Naval Base Guam Munitions Site, along with ravine forests along drainages.

Figure 3.10-3: Representative Vegetation Community Types on Guam

Two subtypes of the limestone community type are recognized: disturbed limestone forest and halophytic-xerophytic scrub (salt tolerant vegetation on exposed and thin-soiled slopes and rock flats). Disturbed limestone plant communities are usually dominated by nonnative woody species of relatively short heights. The floristic composition represents subclimax seral stages following human-induced disturbances such as land clearing. The canopy of disturbed limestone forest is fairly open, which allows abundant sunlight to reach the forest floor. The majority of the woody biomass in the disturbed areas is derived from nonnative species, including tangantangan (*Leucaena leucocephala*), lemondichina (*Triphasia trifolia*), and papaya (*Carica papaya*). Some areas of disturbed limestone forest are dominated by larger, nonnative trees such as African tulip (*Spathodea campanulata*) and ahgao manila (*Vitex parviflora*). Scattered niyok or coconuts (*Cocos nucifera*) are common overstory components of disturbed limestone forests. Inland groves of coconuts are the remnants of copra plantations. Native species can be present in the understory, including kafo, nanaso (*Scaevola sericea*), panao (*Guettarda speciosa*), and nunu. The open understory, the result of ungulate browsing, rooting, and trampling, is occupied by various nonnative grasses, vines, and weeds. Chromolaena (*Chromolaena odorata*), known as masiksik in the Chamorro language, is a common nonnative shrub in recently disturbed areas (U.S. Department of the Navy 2013a).

The halophytic-xerophytic scrub subtype of the limestone community is a unique plant community that exists on limestone terraces and cliff edges. The presence of drying winds, exposure to salt spray, and excessively drained limestone soil result in a microclimate that supports a stunted, wind-pruned plant community. The floristic diversity in these communities varies from low to high. Common species in halophytic-xerophytic scrub communities include nigas (*Pemphis acidula*), nanaso, panao, chopak (*Mammea odorata*), hunik (*Tournefortia argentea*), lodugao (*Clerodendrum inerme*), kafo, pago (*Hibiscus tiliaceous*), langiti, nunu, gasoso (*Colubrina asiatica*), lalahag (*Jasminum marianum*), and gulos (*Cynometra ramiflora*) (U.S. Department of the Navy 2013a).

Ravine Communities. Fosberg (1960) classified the forest vegetation in valleys and ravines in southern Guam as ravine forests. Although the floristic composition of the ravine communities is similar to the limestone communities, these forests generally occur on volcanic soil or on argillaceous or clayey limestone soil, and are quite variable in floristic composition. Plant communities are often defined by the variability in soil moisture. Valley bottoms and ravines often have higher soil moisture than on the upper slopes. Canopies of ravine forest are structurally complex with multiple layers. Species present often include dukduk, pago, kafo, nunu, chosga (*Glochidion mariannensis*), ahgao, nunu, fagot, langiti, and da'ok (*Calophyllum inophyllum*). Because of their proximity to freshwater streams in southern Guam, these plant communities contain many species of cultivated plants such as coconut, betelnut palm or pugua (*Areca catechu*), alangilang (*Cananga odorata*), and banana or chotda (*Musa* spp.). Epiphytes and common woody climbers (i.e., lianas) are also present (U.S. Department of the Navy 2013a).

A disturbed ravine forest subtype is also recognized. Disturbed ravine plant communities are usually dominated by nonnative woody species with a more open canopy. The floristic composition represents subclimax seral stages following human-induced disturbances, such as agriculture. The majority of the woody biomass in the disturbed ravine forest is usually derived from nonnative species. Ahgao manila and alangilang are common components of disturbed ravine forests on Guam. The open understory is occupied by various nonnative grasses, vines, and weeds (U.S. Department of the Navy 2013a). Ravine forests and disturbed ravine forests are limited to the Naval Base Guam Apra Harbor and Naval Base Guam Munitions Site.

Wetland Communities. Wetlands are areas subject to permanent or periodic inundation by surface or groundwater with a frequency sufficient to support a prevalence of vegetative or aquatic life that require saturated or seasonally saturated soil conditions for growth and reproduction. The surface or subsurface water must be sufficient for the establishment of hydrophytes or development of hydric soil or substrates. Wetlands generally include swamps, marshes, bogs, and similar areas, such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds (U.S. Department of the Navy 2013a). The northern limestone plateau of Guam is generally lacking in substantial wetlands (U.S. Department of the Navy 2013a).

Fosberg (1960) described seven subtypes of wetland plant communities based on their dominant floristic composition. Fosberg defined swamps as supporting plant communities with a predominance of woody species, and marshes as supporting herbaceous plant communities (Fosberg 1960). Marshes are generally situated in low places along the coast, along streams, in depressions and sinkholes with argillaceous limestone, or in poorly drained areas with volcanic soil. Marshes can be inundated with freshwater or brackish water if near the ocean. Swamps are generally situated along rivers, especially near the coast or along river valleys if inland, and are usually designated as ravine communities rather than as wetland communities (U.S. Department of the Navy 2013a).

Most marshes on Guam are floristically simple with few dominant plant species. Karisu (*Phragmites karka*), a tall, reedy perennial grass, is the most common marsh species, often forming a dense monocultural plant community. *Scirpus littoralis*, a perennial sedge with rhizomes, is also found in dense pure stands along stream banks and in estuaries. Langayao (*Acrostichum aureum*), a large fern, can dominate some marshes. Other floristic components of wetland plant communities on Guam can include introduced invasive grasses and sedges (U.S. Department of the Navy 2013a).

Mangroves, freshwater and brackish swamps of woody vegetation, on Guam are the largest category of wetlands and can be found on the edges of marshes, along river courses, and in wet depressions in forests. Pago is usually the dominant species, although the largest tract of swamp forest on the island, the Talofofo River Valley to the east of Naval Base Guam Munitions Site, is dominated by langasat (*Barringtonia racemosa*). Other trees that might be present are kafo, gulos, and the betelnut palm (Guam Division of Aquatic and Wildlife Resources 2006). Natural freshwater marshes are also common on Guam. Most are dominated by dense, nearly pure stands of karisu that are 6 to 16 ft. (1.8 to 4.9 m) tall. Other grasses (e.g., *Panicum muticum*), sedges (e.g., *Eleocharis ochrostachys* and *Cyperus* spp.), and langayao are often present but are usually less prevalent (Guam Division of Aquatic and Wildlife Resources 2006). Vegetation in man-made freshwater habitats is variable, but karisu and pago are usually present (Guam Division of Aquatic and Wildlife Resources 2006).

Coastal Strand Communities. Strand vegetation is adapted to excessively drained soil and salt spray from adjacent coastal waters. Many beach areas on Guam are occasionally inundated with salt water during storms, which imposes a controlling influence on all biota. Strand communities vary floristically and in diversity. Backstrand communities usually are inundated at high tide and dry out at low tide. Some common overstory species found in strand plant communities include coconut, gagu (*Casuarina equisetifolia*), nonak (*Hernandia* spp.), and da'ok. Where an overstory is lacking or the canopy is open and a shrub layer is common, the shrub species often include nanaso, hunik, and pago. Vines, including morning glory or halaihai (*Ipomoea* spp.), are often present. Grass species on these coastal strands can include bunchgrass (*Lepturus repens*) and *Paspalum distichum* (U.S. Department of the Navy 2013a). Strand plant communities are limited to narrow strips in coastal areas within Naval Base Guam, Main Cantonment Area, and Andersen Air Force Base (AFB).

Savanna Communities. Savannas, defined as grasslands with scattered individual or clumps of trees, cover extensive areas in southern Guam. Savannas are predominately found on volcanic soil and are maintained by periodic burning initiated by humans (U.S. Department of the Navy 2013a). If left undisturbed, savanna communities would gradually be colonized by an increasing number of woody trees and shrubs, and convert to a ravine or limestone forest depending on the soil type (U.S. Department of the Navy 2013a). These five savanna plant communities were recognized by (Fosberg 1960): (1) *Miscanthus*, (2) *Dimeria*, (3) erosion scar, (4) karisu, and (5) weed communities.

3.10.2.1.1.1 Andersen Air Force Base

Basewide vegetation surveying and mapping were conducted on Andersen AFB in 2007 and 2008, and included quantitative characterization of 3,211 randomly located plots on 15,371 ac. (6,220.4 ha) on Andersen AFB proper and the adjacent Guam National Wildlife Refuge on Ritidian Point (U.S. Department of the Navy 2013a). Twenty-two distinct communities (21 vegetative communities and disturbed land) were observed on Andersen AFB within the survey area (U.S. Air Force 2008). Vegetation community types were named in accordance with the Fosberg (1960) classification, with secondary forest subdivisions based on descriptions of Donnegan et al. (2004). Community types were typically named by the dominant or keystone plant species therein. No wetlands are identified on Andersen AFB (U.S. Air Force 2008).

The predominant vegetation type in undeveloped areas on Andersen AFB is limestone forest. This vegetative community occurs along portions of the western boundary and the northern and eastern boundaries of the installation, atop the plateau, on the fore slope (cliff face), and at the toe of the cliff slope.

Excellent examples of native strand vegetation are found on coastal areas of Andersen AFB. Strand plants are characteristically salt tolerant, thrive in sandy soil or on rocky coasts, and tolerate direct sunlight and hot, dry conditions. Major components of the coastal strand flora include trees and shrubs such as nanaso, hunik (*Tournefortia argentea*), masiksik hembra (*Triumfetta procumbens*), panao, nonak, binalo (*Thespesia populnea*), gagu, langasat, and coconut trees. Rocky coasts typically support stunted, wind-sheared shrubs.

3.10.2.1.1.2 Naval Base Guam Telecommunications Site

Three plant communities were described on Naval Base Guam Telecommunications Site (the northern portion previously called Finegayan North) in 2008: limestone forest, coconut forest (remnants of copra plantations), and disturbed/weed community (successional vegetation between vegetation types) (U.S. Department of the Navy 2013a). The disturbed/weed plant community occurs at forest edges and in patches within the forest (U.S. Department of the Navy 2013a). The predominant vegetation community in the southern portion of the area (Andersen South, previously called South Finegayan) is disturbed limestone forest (U.S. Department of the Navy 2013a).

Limestone forests on Naval Base Guam Telecommunications Site occur on the upper plateau and below the cliffline (U.S. Department of the Navy 2013a). The majority of the plateau area supports disturbed limestone communities composed of nonnative species (U.S. Department of the Navy 2013a). In the forests of the southern section of Naval Base Guam Telecommunications Site, the three species with the highest relative densities were paipai, kafo, and fagot, which are all native species and collectively account for 62 percent of the overall density. All native tree species within the southern section of Naval Base Guam Telecommunications Site had a combined density of 87 percent. Two native tree species, paipai and mapunao, are endemic to the Mariana Islands and have a combined density of 27 percent (U.S. Department of the Navy 2013a).

The limestone forested area in the southern portion of Naval Base Guam Telecommunications Site is dominated by nonnative ahgao manila, tangantangan, and papaya, which comprise 67 percent of the number of trees. The remaining 33 percent of tree cover is by five native species. The low native tree component might be the result of past clearing activities at the annex (U.S. Department of the Navy 2013a).

3.10.2.1.1.3 Andersen South

The most common native tree species within the disturbed limestone forest on Andersen South include the following: pago, paipai, lada (*Morinda citrifolia*), fagot, and ahgao (*Premna obtusifolia*). The most common introduced tree species on Andersen South include the following: ahgao manila, tangantangan and pickle tree (*Averrhoa bilimbi*). Aside from pickle tree, other nonnative species in the survey, such as papaya and custard apple (*Annona reticulata*), produce edible fruits that are likely dispersed by ungulate activity (U.S. Department of the Navy 2013a).

3.10.2.1.1.4 Naval Base Guam Barrigada

Activities carried out at Naval Base Guam Barrigada require large amounts of cleared, maintained land for operation. Vegetation communities include tangantangan scrub, limestone forest, disturbed limestone forest, shrub/grassland, and wetlands. The disturbance of land has led to an increase of nonnative and invasive species. The degree of disturbance within the annex results in portions of the remaining forested plant communities being highly modified and dominated by tangantangan and African tulip (U.S. Department of the Navy 2013a).

Twenty tree species were documented on transects quantified during the 2008 vegetation surveys performed on Naval Base Guam Barrigada (U.S. Department of the Navy 2013a). The most commonly observed trees included nunu, pago, and fagot. All three species are native to Guam. Paipai, which is also native, is a dominant understory species within the forests on Naval Base Guam Barrigada. Common introduced species on Naval Base Guam Barrigada include custard apple, limeberry, and tangantangan. Native species have a combined relative density of approximately 77 percent, far exceeding the relative density of introduced species for the survey transects at Naval Base Guam Barrigada (U.S. Department of the Navy 2013a).

3.10.2.1.1.5 Naval Base Guam Main Base

Naval Base Guam Main Base includes Naval Base Guam Polaris Point, Naval Base Guam Apra Harbor, Sasa Valley Tank Farm, and Tenjo Vista Tank Farm. Vegetation communities on Naval Base Guam Main Base include limestone, ravine, and wetland communities. Limestone communities are situated on slopes found within Naval Base Guam Main Base. Relatively large disturbed limestone communities are present on the lower slopes of Orote Peninsula and a narrow band of halophytic-xerophytic scrub communities exists on the cliff faces (U.S. Department of the Navy 2013a).

Vegetation surveys were performed along a transect in the upper plateau to the west of the old runway in the southern sector of Orote in 2008. The area has rugged limestone karst topography. The limestone forest is characterized by native fagot, which comprises 28 percent of the relative density. Collectively, approximately one-third of the relative tree density within this transect is composed of introduced understory tree species (i.e., tangantangan, limeberry, and papaya). The remaining two-thirds of the relative density are composed of native species, including the Mariana Islands endemic species mapunao. Absolute cover was highest for native upper canopy tree species, including nunu, umumu, and fai'a (*Tristiropsis acutangula*) (U.S. Department of the Navy 2013a). Based on the 2008 vegetation survey on Naval Base Guam Polaris Point, tangantangan comprises 88 percent of the tree layer within the transect (U.S. Department of the Navy 2013a).

Within the Naval Base Guam Main Base, ravine forests are restricted to narrow strips along the few freshwater drainages near the coast (U.S. Department of the Navy 2013a). Manmade wetlands are found at Sasa Valley Tank Farm and Tenjo Valley Tank Farm.

3.10.2.1.1.6 Naval Base Guam Munitions Site

Vegetation communities on the Naval Base Guam Munitions Site include limestone, ravine, wetland, and savanna communities. Limestone communities are situated on elevated limestone terraces, plateaus, and slopes found within the Naval Base Guam Munitions Site. The Naval Base Guam Munitions Site has the largest extent of interior limestone communities on Joint Region Marianas lands on Guam. These limestone communities persist on the ridge tops and upper slopes from Mount Lamlam northward to Mount Alifan. A narrow band of a halophytic-xerophytic scrub plant community is delineated near Mount Almagosa on the Naval Base Guam Munitions Site (U.S. Department of the Navy 2013a).

The ravine forest plant communities are abundant in the Naval Base Guam Munitions Site, occupying much of the south-central portion of the installation. Swamps, delineated as ravine communities, are often present on argillaceous limestone soil, bottomlands, and in depressional areas. Pago and kafo are the most common woody plants associated with these communities, often forming dense thickets. Langasat, a tall forest tree, dominates bottomland forest in areas along the Talofofo River. Extensive areas of disturbed ravine forest are also present in the Naval Base Guam Munitions Site, especially in areas subjected to low-intensity ground fires and past human disturbance. Several acres of coconut plantations still exist within the Naval Base Guam Munitions Site (U.S. Department of the Navy 2013a).

Twelve native species were documented along transects during the 2008 vegetation surveys within the ravine forests in the northern sector of the Naval Base Guam Munitions Site: akgak, pago, da'ok, chosgo (*Glochidion marianum*), *Melastoma malabathricum*, fadang, lada, gulos, chi'ute, pahong, *Discocalyx megacarpum*, and a'abang (*Eugenia reinwardtiana*) (U.S. Department of the Navy 2013a). Native tree species dominate the relative density of trees in all transects in the northern sector. Akgak and pago are the most dominant native species in the northern sector (U.S. Department of the Navy 2013a). Common introduced tree and shrub species within the northern sector include the betelnut palm, ahgao manila, the invasive bay rum tree (*Pimenta racemosa*), and limeberry (U.S. Department of the Navy 2013a).

A 2009 vegetation survey in the ravine forest in the valley slopes surrounding Mount Almagosa in the southern sector of the Naval Base Guam Munitions Site characterized the native fai'a (*Merrilliodendron megacarpum*) as the native species comprising more than 63 percent of the relative density. The ravine forest along the Sadog Gagu River in the southern sector of the Naval Base Guam Munitions Site is dominated by coconut and two introduced species, ahgao manila and betelnut palm. The overall relative density of native species along the Sadog Gagu River is approximately 33 percent, which is lower than the densities observed in ravine forest transects in the northern sectors of the Naval Base Guam Munitions Site. In the ravine forest in the southwestern sector of the installation, south and west of the explosive ordnance disposal range, the introduced species coconut and betelnut palms and native kafo trees are dominant (U.S. Department of the Navy 2013a).

Fena Dam, built in 1951, contains Fena Reservoir, the largest freshwater body of water on Guam. Fena Reservoir is approximately 200 ac. (81 ha), the shallow water fringes of the lake are dominated by karisu. The Naval Base Guam Munitions Site contains the greatest area of wetlands on DoD-owned or leased lands in Mariana Islands (U.S. Department of the Navy 2013a). Most of these freshwater wetlands are adjacent to the rivers or their tributaries. Wetlands on the Naval Base Guam Munitions Site occur in limestone forest, ravine forest, and savanna communities. Common forested wetland species include pago, coconut, kafo, and the betelnut palm (U.S. Department of the Navy 2013a).

Erosion in savanna communities is particularly evident within the Naval Base Guam Munitions Site. Large areas of bare ground are present primarily due to degraded soil and destruction of vegetation by feral ungulates. Subsequent slope failures expose bare ground.

3.10.2.1.2 Rota

Training activities on Rota described in this EIS/OEIS are limited to Rota International Airport and other areas in conjunction with local law enforcement. The infrequent use of locations on Rota occurs in developed areas, not in Rota's natural areas that support special status species. An overview of Rota's natural vegetation communities and locations of special ecological interest is included below.

No major military battles occurred on Rota during World War II. Therefore, the island of Rota was spared much of the ecological destruction that occurred on Guam, Saipan, and Tinian. With a small human population and limited agriculture, Rota has also been less developed than the other islands in the southern portion of the archipelago. The vegetation communities on Rota includes primary and secondary limestone forest, atoll forest, agricultural forest, coconut plantations, Formosan koa forest, secondary vegetation, open fields, grassland, and urban vegetation (Fosberg 1960, Mueller-Dombois and Fosberg 1998).

Rota also has a substantial portion of land in designated conservation areas, and other lands also remain relatively undisturbed. Consequently, intact limestone forest covers a majority of the island. Rota also hosts several rare plants, including *Tabernaemontana rotensis*, and nearly all *Serianthes* trees in existence (both of these species also occur on Andersen AFB on Guam). Two other ESA-listed plant species occur exclusively on Rota—*Osmoxylon mariannense*, and *Nesogenes rotensis* (U.S. Fish and Wildlife Service 2006c).

The Sabana region is an uplifted plateau 1,476 ft. (450 m) in elevation covering approximately 5 square miles (13 square kilometers) on the western half of the island. This area supports dense limestone forests and also includes the known locations of the ESA-listed *Osmoxylon mariannense.* Cliffs border the Sabana on all sides except to the northeast, where the Sabana slopes down to the eastern part of the island, which has been covered since the 1930s in secondary growth forest intermingled with residential and agricultural lands. The cliff lines surrounding the plateau remain primary forest due to their steepness, a hindrance to past agricultural development. The plateau's western cliffs support the Rota population of the ESA-listed *Serianthes* tree. The I'Chinchon Bird Sanctuary is located on the northeastern coastline of Rota. The sanctuary is an important seabird and shorebird location and contains intact limestone forest and exposed limestone outcrops suitable for nesting habitat. This area is also the location of one of two populations of the ESA-listed *Nesogenes rotensis*.

Most of the ecological services provided by the native vertebrates, such as insectivory, pollination, and seed dispersal, still appear to function on Rota (Hess and Pratt 2006). In addition, however, introduced deer are responsible for unnatural native plant herbivory, and rats (*Rattus* spp.) are likely seed predators, as well as nest predators of native birds. The abundant Black Drongo (*Dicrurus macrocercus*) may also be responsible for nest predation of native forest birds. Despite these depredations and frequent typhoons, limestone forest regeneration processes appear to be unimpeded in comparison to Guam. Abundant birds that disperse large seeds include the Mariana fruit dove and the white-throated ground dove, whereas the Micronesian honeyeater may serve as an important pollinator bird species (Hess and Pratt 2006).

3.10.2.1.3 Tinian Military Lease Area

Tinian consists of a series of five limestone plateaus at various elevations, separated by escarpments and steeply sloping areas (U.S. Department of the Navy 2013a). These areas are described in more detail below.

3.10.2.1.3.1 Limestone Forests

Limestone forests fall into three types: mixed forest, coastal forest, and halophytic-xerophytic shrub. Mixed forest is classified as a cliff-line ecosystem. These forests occur on the peak of Mt. Lasso and areas surrounding the north escarpment of Maga. The coastal and halophytic-xerophytic forests occur in near-shore ecosystems. Limestone forests occurring in cliff-line ecosystems are referred to as "typhoon forests" due to adaptations in the vegetation promoting forest regeneration in the presence of typhoon damage. Some plant species will reproduce by generating new shoots from fallen branches and by flowering in exposed areas cleared by wind damage. Vegetation that occurs in typhoon forests includes umumu, gulos, nunu, and paipai.

Coastal limestone forest occurs on slopes above the ocean. Plants found in this vegetative community include chi'ute (*Cerbera dilatata*), langiti, paipai, and kafo. Coastal limestone forests can be found at Unai Masalok.

Halophytic-xerophytic scrub vegetation occurs in near ocean habitat on limestone rocks. The dominant plant species in a halophytic-xerophytic scrub habitat is *Pemphis acidula* (U.S. Department of the Navy 2013a).

3.10.2.1.3.2 Secondary Growth Forests

Secondary growth forests contain a mixture of native and introduced trees, shrubs, and dense understory plants. These forests comprise parts of the lowland ecosystem. Dominant trees include tangantangan, kamachili (*Pithecellobium dulce*), and gago (*Casuarina equisetifolia*), with rare occurrences of *Acacia confusa*. Dense stands of piao (*Bambusa vulgaris*) can also be found in secondary forests.

Tangantangan forest dominates mainly the level to moderately sloping areas at the north end of the island. Tangantangan is also included in secondary growth forest and is a part of the lowland ecosystem. However, on Tinian there are extensive homogeneous stands of this species. Often the stands are interspersed with *Panicum maximum*, which grows to 6 ft. (1.8 m) tall (U.S. Department of the Navy 2013a).

3.10.2.1.3.3 Open Fields and Grasslands

Open field habitat is characterized by grass and other ground-covering vegetation with small thickets of native and introduced vegetation. Open field habitat is also included as a component of the lowland ecosystem. Generally, these fields occur in areas of historical cattle grazing. Introduced species such as lantana (*Lantana camara*), morning glory, climbing hempvine (*Mikania scandens*), and giant false sensitive plant (*Mimosa invisa*) are present in open fields as well as small groves of trees, including African tulip tree (*Spathodea campanulata*).

Vegetation present near open water area is typically dominated by *Schoenoplectus litoralis* var. *capensis*, with patches of langayao and *Paspalum orbiculare*. This band of mixed vegetation is surrounded by a band of karisu, an obligate wetland species (U.S. Department of the Navy 2013a). Crop plants have been planted in areas, and these disturbed areas contain gago, vines, and weedy herbs.

3.10.2.1.3.4 Wetlands (Freshwater)

The karisu area surrounding Hagoi Wetland is approximately 57 ac. (23.1 ha). The wetland submergent plant-like algae, *Chara* spp., is abundant in some of the open water areas within sedge vegetation. Green algae (Chlorophyta) are also present and increase during the dry season. During the dry season, more than 50 percent of the open water areas was found to be covered with algae (U.S. Department of the Navy 2013a).

3.10.2.1.3.5 Strand Vegetation

Strand vegetation occurs on sandy beaches, and is often mixed with halophytic-xerophytic species. This vegetation type is a component of the coastal ecosystem. Tinian beaches consisting of strand vegetation are Unai Chulu, Unai Babui, Unai Chiget, and Unai Dangkulo (U.S. Department of the Navy 2013a). Vegetation in strand habitat includes hunik, beggar's tick (*Bidens alba*), blue porterweed (*Stachytarpheta jamaicensis*), lantana, binalo, and morning glory. *Euphorbia sparrmannii* var. *tinianensis*, is a semi-succulent herb endemic to Tinian and occurs only at Unai Masalok. Lamanibot Bay and other headland communities are valued as healthy xerophytic-halophytic scrub and can contain ufa halom-tano (*Heritiera longipetiolata*) (U.S. Department of the Navy 2013a). *Heliotropium anomalum* can be found near the cliff slope rim terrace pools created by the Unai Chiget blow hole and is not reported elsewhere on Tinian. The Unai Chiget region also includes a forest of nonak trees. Dense areas of this tree are not common in its range and this particular stand is unique on Tinian.

3.10.2.1.4 Saipan Marpi Maneuver Area

As described in Chapter 2 (Description of Proposed Action and Alternatives), Marpi Maneuver Area is authorized for training; however, the area is seldom used. Portions of the Marpi Maneuver Area are owned by CNMI, and other portions are privately owned. The Marpi Maneuver Area is 374.5 ac. (151.5 ha) and is characterized by tangantangan thickets and elephant grass meadows with some limestone forest areas in the southwestern portion of the facility. With the coordination of the Army Reserve Unit Saipan and the approval of CNMI government, land navigation training is conducted on non-DoD lands within the Marpi Maneuver Area (shown on Figure 2.1-11, east side of northern Saipan). Land navigation training does not include vehicular training, and no fires are allowed for associated bivouac activities. Generally, maneuver training on Saipan is infrequent and rare.

3.10.2.1.5 Farallon de Medinilla

The U.S. military has used the island of FDM as a bombing range since at least 1971, and the agreement between the U.S. Government and the CNMI was formalized in a 50-year lease agreement (United States of America and Commonwealth of the Northern Mariana Islands 1983). Few vegetation surveys have been conducted on FDM. The first published flora record by Fritz in 1902 described the island as a plateau covered by brush approximately 13 ft. (4.0 m) high (Mueller-Dombois and Fosberg 1998); however, aerial photographs from 1944 show large canopy trees on FDM (Figure 3.10-4). FDM's vegetation appears to have undergone significant changes since the island was leased by the DoD and the subsequent bombardment for military training. The most intensive bombardment to date of FDM occurred during the Vietnam era, when as much as 22 tons of ordnance per month was dropped on the island (Lusk et al. 2000). Based on early 20th century descriptions of FDM vegetation and aerial photographs of the island prior to military bombardment activities, island tree height and canopy cover have been greatly reduced (Lusk et al. 2000; Mueller-Dombois and Fosberg 1998).

A brief botanical survey of the northern portion of the island carried out in 1996 identified 43 plant species, 32 of which were native (U.S. Department of the Navy 2013a). Vegetation on FDM may be grouped into coastal vegetation, cliff-line vegetation, and vegetation on the upper plateau known as the mesic terrace system. These vegetation types are described below.

3.10.2.1.5.1 Coastal Vegetation

Along the windward shoreline of FDM are large boulders interspersed with cobbles. The boulders are covered with microalgae of the genera *Padina*, *Liagora*, and *Asparagopsis*. The emergent portion of the beach is composed of rubble/cobbles with little sand and no vegetation (U.S. Department of the Navy 2013a). In the region of the isthmus is a reef terrace in the form of a ridge and spur system with sand channels. Algae of the genera *Padina*, *Dictyota*, *Hamimeda*, *Lyngbya*, *Liagora*, *Neomeris*, and *Calupera* cover the upper surface of the ridges (U.S. Department of the Navy 2013a). Along the leeward coastline is a structurally unique submerged shoreline forming a vertical wall to a depth of 49 to 66 ft. (15.0 to 20.1 m), undercut by ledges and caves. The exposed wall supports the green calcareous algae *Halimeda* and calcareous red algae (U.S. Department of the Navy 2013a).

3.10.2.1.5.2 Cliff-Line Vegetation

The dominant plant species in the cliff-line communities are *Exocoecaria aqallocha*, with less coverage by *Digitaria gaudichaudii*, *Bikkia tetandra*, *Hedyotis stringulosa*, and *Portulaca oleracea* (Lusk et al. 2000).

Notes: 1. Left panel photograph (circa 1944) shows apparent taller stature vegetation within the mesic terrace vegetation type in the central portion of the island (Source: U.S. Department of the Navy 2013a). 2. Right panel photograph (2012) shows recently cleared targets within range areas. Mesic terrace lacks forests evident from the 1944 photograph (Source: Google Earth 5.1 2012).

Figure 3.10-4: Reduction of Forest Communities on Farallon de Medinilla by Military Bombardment and Typhoons

3.10.2.1.5.3 Mesic Terrace System

Most of the mesic terrace ecosystem is dominated by dense herbaceous plant communities. Soil on the terrace is more developed and has higher moisture content than the cliff-line ecosystem soil. As a result, the once forested mesotropic environment supports greater diversity of plant species than observed in the cliff-line ecosystem. This area receives most of the ordnance at FDM, and subsequently has been altered the most in terms of structure and composition (from closed canopy forested areas to dense herbaceous and shrub cover (Lusk et al. 2000).

3.10.2.2 Wildlife Communities

3.10.2.2.1 Guam Department of Defense Lands

3.10.2.2.1.1 Birds

Three endemic bird species from the Mariana Islands occur in small populations on Guam. The Mariana common moorhen persists in low numbers throughout Guam and on military-owned lands. The Mariana swiftlet was once common throughout the island but is now restricted to three caves on the Naval Munitions Site in southern Guam. The Micronesian starling, listed as endangered by Guam but not by the Federal government, was nearly extirpated in the early 1990s; however, it currently appears to be making a modest recovery and occurs in small numbers on Andersen AFB, Cocos Island, parts of Hagatna, Apra Harbor, and some coastal areas in southern Guam (U.S. Department of the Navy 2013a). Two other native terrestrial avian species are still found on military lands, neither of which is listed as threatened or endangered, but both are protected by the MBTA. These are the yellow bittern (*Ixobrychus sinensis*) and Pacific reef heron (*Egretta sacra*). The yellow bittern is the only native land bird that is still considered to be common on Guam (U.S. Department of the Navy 2013a). The Mariana crow has not survived in the wild on Guam and is believed to be extirpated from the island.

ESA-listed bird species are addressed in more detail in Section 3.10.2.3 (Endangered Species Act Listed Species). Seabirds and shorebirds protected under the MBTA, are addressed separately in Section 3.6 (Marine Birds).

Several nonnative bird species are also present on Guam, which were either unintentionally introduced or intentionally introduced to provide hunting resources. Commonly observed introduced avian species include the island collared dove (*Streptopelia bitorquata bitorquata*), Eurasian tree sparrow (*Passer montanus*), black francolin (*Francolinus francolinus*), and the black drongo (*Dicrurus macrocercus harterti*). Guam Division of Aquatic and Wildlife Resources officially closed the dove hunting season in 1987; however, feral pigeons may be legally shot when it is legal to discharge a firearm (U.S. Department of the Navy 2013a). The island collared dove is present on all Joint Region Marianas lands on Guam (U.S. Department of the Navy 2013a). The Eurasian tree sparrow is commonly observed in small flocks, usually close by manmade structures. Black francolins were introduced to southern Guam as a game bird by the USFWS in 1961 and currently inhabit a variety of habitat types throughout the island, including Andersen AFB. The black drongo was introduced to Rota by the Japanese in the 1930s. The black drongo eventually spread to Guam and is considered a nuisance species that can be hunted at any time of the year. The black drongo occurs mostly in developed areas (U.S. Department of the Navy 2013a).

3.10.2.2.1.2 Mammals

Three species of bats, the Mariana fruit bat (*Pteropus mariannus mariannus*), the little Mariana fruit bat (*P. tokudae*), and the Pacific sheath-tailed bat (*Emballonura semicaudata rotensis*) were historically the only native mammals on Guam. The Pacific sheath-tailed bat has been extirpated from the island, while the little Mariana fruit bat is thought to be extinct. The Mariana fruit bat is federally listed as threatened; therefore, this species is addressed under Section 3.10.2.3 (Endangered Species Act Listed Species).

Spanish introductions included Asiatic water buffalo (known as carabao in Chamorro) (*Bubalus bubalis*), Philippine deer (*Cervus mariannus*), dogs (*Canis familiaris*), cats (*Felis catus*), feral pigs (*Sus scrofa*), goats (*Capra hircus*), and cattle (*Bos taurus*). Three of these introduced species, the Asiatic water buffalo, Philippine deer, and feral pigs, have feral populations that are damaging natural resources on Guam (U.S. Department of the Navy 2013a). Other introduced species include the Indian musk shrew (*Suncus murinus*) and several rodent species such as the common house mouse (*Mus musculus*), Malayan black rat (*Rattus rattus diardii*), roof rat (*Rattus rattus*), Polynesian rat (*Rattus exulans*), and the Norwegian rat (*Rattus norvegicus*) (Wiewel et al. 2009).

3.10.2.2.1.3 Reptiles and Amphibians

Native reptile species known to still exist on Guam include stump-toed (mutilating) gecko (*Gehyra mutilata*), blue-tailed skink (*Emoia caeruleocauda*), Slevin's skink (*Emoia slevini*), moth skink (*Lipinia noctua*), snake-eyed skink (*Cryptoblepharus poecilopleurus*), Pacific slender-toed gecko (*Nactus pelagicus*), mourning gecko (*Lepidodactylus lugubris*), oceanic gecko (*Gehyra oceanica*), Micronesian gecko (*Perochirus ateles*), green sea turtle (*Chelonia mydas*), and hawksbill sea turtle (*Eretmochelys imbricata*) (Christy et al. 2007a, 2007b). Red-eared sliders (*Trachemys scripta elegans*) and snapping turtles (*Chelydra serpentinaare*) were recently introduced to some freshwater and brackish aquatic sites on Guam (Vogt and Williams 2004, U.S. Department of the Navy 2013a). The monitor lizard (*Varanus indicus*), which is common in some areas on Guam, is considered an early introduction to the Mariana Islands, approximately 1,600 years ago (Pregill and Steadman 2009). Sea turtles are discussed separately in Section 3.5 (Sea Turtles).

There are no native amphibian species on Guam; however, several nonnative amphibians have been introduced, including the marine toad (*Rhinella marina*), greenhouse frog (*Eleutherodactylus planirostris*), eastern dwarf tree frog (*Litoria fallax*), Guenther's Amoy frog (*Rana guntheri*), Hong Kong whipping frog (*Polypedates megacephalus*), Pacific chorus frog (*Pseudacris regilla*), slender-digit chorus frog (*Kaloula picta*), white-lipped tree frog (*Polypedates leucomystax),* grass frog (*Fejervary limnocharis*), crab-eating frog (*Fejervarya cancrivora*), and marbled pygmy frog (*Microhyla pluchra*) (Vogt and Williams 2004, Christy et al. 2007a, 2007b). Incidental occurrences of the Malaysian narrowmouth toad (*Kaloula pulchra*) and coqui (*Eleutherodactylus coqui*) have been recorded but neither species has become established on Guam (Christy et al. 2007a, 2007b).

The primary cause of the decline in native reptile populations on Guam is probably predation by introduced animals, including brown treesnakes, cats, and rats (*Rattus* spp.). The population of the blue-tailed skink has declined in response to predation or competition from the curious skink (*Carlia fusca*); however, it is relatively common in appropriate habitat (Fritts and Leasman-Tanner 2001, Vogt and Williams 2004). The stump-toed gecko has also declined, apparently in response to predation by introduced vertebrate predators, including rats, cats, shrews, and the brown treesnake. The mourning gecko is relatively common (Fritts and Leasman-Tanner 2001).

3.10.2.2.1.4 Invertebrates

Guam is home to dozens of endemic invertebrate species, many of which are rare or have extremely limited ranges. Endemic invertebrate species include the Mariana eight-spot butterfly (*Hypolimnas octocula marianensis*) and an undescribed *Catacanthus* species, known as the bronze boonie bug. Guam also supports three native tree snail species (humped tree snail [*Partula gibba*], fragile tree snail [*Samoana fragilis*], and Guam tree snail [*Partula radiolata*]). Additionally, Guam has a number of endemic invertebrate cave species that are likely extremely limited in their distribution. Among these are the Almagosa Cave amphipod (*Melita* spp.), at least three Almagosa isopods (*Isabelloscia* spp.), and the Guam karst katydid (*Salomona guamensis*).

The three native tree snails, Mariana eight-spot butterfly, and Mariana wondering butterfly are considered candidates for listing under the ESA. Population declines of native tree snails are likely due to overgrazing of vegetation by ungulates resulting in a loss of forest habitats, and the predation by introduced species, namely the terrestrial flatworm (*Platydemus manokwari*) and rosy wolfsnail (*Euglandina rosea*) (U.S. Department of the Navy 2013a). Overbrowse of nurse plants for the Mariana eight-spot butterfly and Mariana wandering butterfly is a major threat to the recovery of this species (U.S. Department of the Navy 2013a).

The native terrestrial crab or panglao (*Cardisoma carnifex*), land hermit crab or umang (*Coenobita brevimanus*) and coconut crab (*Birgus latro*) (known as ayuyu in Chamorro) begin life in the sea. After a planktonic larval stage, small crabs emerge from the ocean to live on land. Mangrove crabs or atmangao live in burrows among the roots of riverbank trees. Land hermit crabs rely on borrowed shells for protection throughout their lives, often using the shell of the introduced giant African land snail (*Achatina fulica*). Coconut crabs are the largest terrestrial land arthropod on Earth. They initially borrow shells, but then develop their own hard exoskeleton. Coconut crabs hide in holes during the day and, like the land hermit crab, forage at night. Land crabs are omnivorous and eat foods such as fruits, seeds, plants, rotting wood, dead insects, and carrion. Coconut, land, hermit and mangrove crabs are all found in various locations of DoD property within the Study Area. Threats to these species include rats, feral pigs, dogs, monitor lizards, and humans (U.S. Department of the Navy 2013a).

3.10.2.2.1.5 Guam National Wildlife Refuge and Overlay Units

The Guam National Wildlife Refuge was established in 1993 to protect and recover ESA-listed species, protect habitat, control non-native species (with an emphasis on the brown treesnake control), protect cultural resources, and provide public recreational and educational opportunities.

The Guam National Wildlife Refuge contains three major administrative units, two of which are considered “overlay refuge units” of DoD-administered properties. Overlay refuge units were established through a Memorandum of Understanding, signed by representatives from the Navy, Air Force, and the USFWS. The establishment and management of the overlay refuge units on military lands provides a commitment by the military and the USFWS to institute a coordinated program centered on the protection of threatened and endangered species and other native flora and fauna, maintenance of native ecosystems, and the conservation of native biological diversity in cooperation with the Guam Division of Aquatic and Wildlife Resources, and in support of the military mission (U.S. Department of the Navy 2013a). The three Guam National Wildlife Refuge units are described below:

- ***Ritidian Unit*: **The Ritidian Unit, in northern Guam, is approximately 772 ac. (312.4 ha), including approximately 370 ac. (149.7 ha) of land and 401 ac. (162.3 ha) of submerged lands. The Unit includes a densely vegetated coastal plain bounded on one side by sheer limestone cliffs jutting to approximately 200 ft. (61.0 m) above sea level. Native vegetation on the Ritidian Unit includes high-quality coastal strand, backstrand, and limestone forest natural communities; a sandy beach; and nearshore marine habitats to the depth of approximately 98.4 ft. (30 m). The terrestrial lands on the Ritidian Unit are designated Critical Habitat for the endangered Mariana crow, the endangered Guam Micronesian kingfisher, and the threatened Mariana fruit bat. Management programs at the Ritidian Unit focus on preserving and restoring essential wildlife habitat, and protection and recovery of endangered and threatened species. Protecting habitat for endangered species also conserves a rich diversity of other plant and animals species. The Ritidian Unit supports a diversity of tropical trees, shrubs, vines, ferns, cycads, grasses, and other species that, in turn, provide habitat for native birds, the Mariana fruit bat, tree snails, coconut crabs, land crabs, skinks, geckos, and myriad native insects.
- ***Andersen Air Force Base Overlay Unit*:** The 10,219 ac. (4,135.5 ha) Air Force Unit at Andersen AFB in northern Guam is contiguous with the Ritidian Unit and includes high-quality native limestone forest, coastal strand, and backstrand natural communities and beaches. The Air Force Unit supported some of the last remaining endangered Mariana crows on Guam, threatened Mariana fruit bats, and endangered *Serianthes nelsoni* trees in the wild, and supports a diversity of other native wildlife and plant species.

- ***Navy Overlay Unit*:** The Navy Unit includes approximately 12,237 ac. (4,952.1 ha) of native habitats in north, central, and south Guam on six land tracts. High-quality habitats on the Navy Unit include limestone forest, backstrand, coastal strand, and beaches in northern and central Guam and ravine forests, limestone forests, mangroves, and wetlands in southern and central Guam. These areas provide habitat for a diversity of tropical plants and wildlife, including threatened Mariana fruit bats, endangered Mariana swiftlets, endangered Mariana moorhen, threatened green turtles, and a rich diversity of other plants, skinks, lizards, land snails, and land crabs. Several freshwater rivers and springs are located on Navy lands and support aquatic fauna.

3.10.2.2.2 Rota

Amar et al. (2008) assessed the trends in abundance of eight terrestrial bird species (Mariana crow, Micronesian honeyeater, Mariana fruit-dove, rufous fantail, Philippine turtle-dove, collared kingfisher, black drongo, and Micronesian starling) on Rota between 1982 and 2004. Only the Micronesian starling increased in abundance. While the introduction of brown treesnakes on Guam has caused the collapse of Guam's native bird populations, brown treesnakes are not the cause of declines in Rota's bird populations (Amar et al. 2008). A nonessential experimental population of Guam rails was established on Rota. Suggested reasons for the decline of the Mariana crow and Rota bridled white-eye on Rota include the impact of introduced predators other than the brown treesnake or habitat loss and degradation of the native tropical forest (Craig and Taisacan 1994, Plentovich et al. 2005). For the Mariana crow, human persecution is also suspected, due to conflicts over land development and habitat protection (Plentovich et al. 2005).

Like Guam, several mammalian species have been intentionally or accidentally introduced to Rota. Feral ungulates (deer and pigs) negatively impact the natural regeneration of native forest in the Sabana region (U.S. Fish and Wildlife Service 2006c). Other mammals such as introduced rats and feral cats are present on Rota.

As stated previously, training activities on Rota described in this EIS/OEIS are limited to Rota International Airport and other areas in conjunction with the CNMI and local Rota government. These locations are in previously developed areas.

3.10.2.2.3 Tinian Military Lease Area

Indigenous wildlife species on Tinian reported in the most recent Integrated Natural Resource Management Plan (U.S. Department of the Navy 2013a) include 46 birds, the majority of which are classified as migratory birds under the MBTA; one bat species (Mariana fruit bat); seven reptile species (two sea turtles, three geckos, and two skinks); and two land crustaceans (coconut crab and land hermit crab). The Mariana common moorhen is reported from the area as well (Amidon 2009). Special-status species are addressed separately below.

3.10.2.2.3.1 Birds

A total of 18 land bird species were detected during one or more of the three surveys conducted between 1982 and 2008 on Tinian (Amidon 2009; Kessler and Amidon 2009, Camp et al. 2012). The most abundant native species were the bridled white-eye, rufous fantail, collared kingfisher, island-collared dove, white-throated ground dove, Mariana fruit dove, white tern, Tinian monarch (see additional discussion below), Micronesian honeyeater, Micronesian starling, and yellow bittern. Monthly monitoring by the Navy and periodic monitoring by CNMI Department of Fish and Wildlife were also conducted and support these observations. Of these species, the bridled white-eye and rufous fantail were the most abundant. The abundance of collared kingfisher, white-throated ground dove, rufous fantail, Micronesian starling, and yellow bittern increased since 1982 while the abundance of Tinian monarch, Mariana fruit dove, and Micronesian honeyeater decreased since 1982 (Camp et al. 2012). Feral chickens are also abundant throughout Navy-leased lands on Tinian (U.S. Department of the Navy 2013a).

The Tinian monarch is an endemic land bird species that nests in limestone, secondary, and tangantangan forest habitats. It was federally delisted in 2004 and was delisted by the CNMI government in 2009. The status of the Tinian monarch was monitored by the USFWS for a period of 5 years, ending in 2009 (Amidon 2009).

3.10.2.2.3.2 Mammals

Introduced mammals on Tinian include cattle, rats, mice, shrews, cats, and dogs. Wiewel et al. (2009) found the Malaysian black rat to be the most abundant species of rat on Tinian. Densities of the Asian house shrew (*Suncus murinus*) are high in native and tangantangan forest; house mice (*Mus musculus*) are also present (Wiewel et al. 2009). All three species are known to severely impact biodiversity of Pacific islands. Rodents and shrews are predators of native birds, lizards, insects, and snails. Rats' omnivorous diet also includes native plants, seeds, and fruit. Changes in forest composition are associated with high rodent density. Aguiguan, an island approximately 5 miles (mi.) (8 kilometers [km]) off of Tinian, supports Pacific sheath-tailed bats. Similar habitats occur on Tinian; however, the Pacific sheath-tailed bat is assumed to be extirpated from Tinian because of a lack of sightings. The Pacific sheath-tailed bat is considered a candidate for ESA listing.

Philippine deer were introduced from Saipan and Rota to Tinian in the 1960s, and were subsequently extirpated through intensive hunting activities through the early 1980s (Wiles 1990). Approximately 500 feral goats inhabited the southeastern coast in the early 1900s before the population was either killed or captured for sale on Saipan (Wiles 1990). Apart from some domesticated goats on farms, it is unclear whether a feral herd still exists on the island (U.S. Department of the Navy 2013a).

3.10.2.2.3.3 Reptiles and Amphibians

Several native reptile species were identified on a recent survey, including the snake-eyed skink, found adjacent to Unai Chulu and in a monitoring plot just northeast of North Field (U.S. Fish and Wildlife Service 2009d). The tide-pool skink was reported as common in the *Pemphis acidula* vegetation zone north of Unai Chulu and thought likely to be present in similar habitat at other locations (U.S. Fish and Wildlife Service 2009d). In 2008 surveys, the blind snake was found in both mixed and limestone forest, but elsewhere in the Mariana Islands, this species has been reported in tangantangan thickets (U.S. Fish and Wildlife Service 2009d).

3.10.2.2.3.4 Invertebrates

Tinian's terrestrial native invertebrate fauna include two crustaceans and one land snail. The coconut crab is a highly valued game species in the CNMI and serves important ecological functions such as dispersing seeds and as scavengers. Hermit crabs are more associated with coastal environments, but some may be found inland. Like coconut crabs, hermit crabs are important scavengers. Tree snails (Partulid snails) are found on Tinian, although populations are likely impacted by Mankowar flatworm predation (U.S. Department of the Navy 2013a). The Langford tree snail and humped tree snail are considered candidates for ESA listing.

3.10.2.2.4 Farallon de Medinilla

3.10.2.2.4.1 Birds

FDM is recognized by regional ornithologists as an important bird area for many species of seabirds and migrant shorebirds (Lusk et al. 2000; U.S. Department of the Navy 2013a; U.S. Fish and Wildlife Service 1990, 1998, 2008a). These seabird and shorebird species are discussed in Section 3.6 (Marine Birds).

The island collared dove and Eurasian tree sparrow are the only introduced bird species recorded from FDM (Lusk et al. 2000; U.S. Department of the Navy 2013a). Sparrows are believed to have colonized FDM from Saipan (Lusk et al. 2000). Four sparrows were observed in 1996 (Lusk et al. 2000), but none were recorded in August 2008 (U.S. Department of the Navy 2008a, c). The ESA-listed Micronesian megapode, which breeds on FDM, is discussed in more detail in Section 3.10.2.3.8 (Micronesian Megapode/Sasangat (*Megapodius laperouse laperouse*).

3.10.2.2.4.2 Mammals

Incidental observations of fruit bats during recent bird surveys, along with fishermen reports from the early 1970s, suggest a small number of fruit bats use FDM, possibly as a stopover location while transiting between islands. Fruit bats are discussed in more detail below. The only other mammalian species known to occur on the island are small-sized rats, believed to be *Rattus exulans.* A common observation during recent natural resource surveys (U.S. Department of the Navy 2008a, c), it is believed that rats negatively impact breeding activities for seabirds and shorebirds on the island (U.S. Department of the Navy 2013a).

3.10.2.2.4.3 Reptiles and Amphibians

Only two species of reptiles are reported on FDM—the Pacific blue-tailed skink (*Emoia caeruleocauda*) and the oceanic snake-eyed skink (*Cryptoblepharus poecilopleurus*) (U.S. Department of the Navy 2008a). No observations of brown treesnakes have been reported on the island.

3.10.2.2.4.4 Invertebrates

Inventories for invertebrate species have not been conducted on this island; accounts of invertebrates have been provided as incidental observations during other natural resource survey efforts. For instance, coconut crabs, including one female with eggs, were observed on FDM in August 2008 (U.S. Department of the Navy 2013a).

3.10.2.3 Endangered Species Act Listed Species

3.10.2.3.1 *Serianthes nelsonii* / (Hayun Lagu or Tronkon Guafi)

3.10.2.3.1.1 Status and Management

The *Serianthes* tree is one of the largest native trees in the Mariana Islands. Tree heights may reach 118 ft. (36.0 m), with a trunk diameter (measured at breast-height) reaching 6.6 ft. (2.01 m). Mature individuals frequently have large spreading crowns, with several of the largest trees on Rota having crown diameters of 69 to 75 ft. (21.0 to 22.9 m). The *Serianthes* tree was listed as endangered under authority of ESA on 18 February 1987 (52 C.F.R. 4907 – 4910), and is listed as endangered by both Guam and CNMI (Guam Public Law 15 – 36, Commonwealth of the Northern Mariana Islands Public Law 2-51). Critical Habitat is not designated for this species.

A number of factors are involved in the decline of this species; however, these causes are poorly studied. Based on initial investigations and field observations, the primary threat on both Rota and Guam is a lack of regeneration probably caused by the browsing of seedlings by deer and by predation on seeds by insects. Other threats include browsing by feral pigs and cattle, typhoon damage, habitat loss, inbreeding, wild fires, and insect infestations (U.S. Department of the Navy 2013a).

3.10.2.3.1.2 Population and Abundance

Rota is believed to support as many as 121 mature trees; however, only one mature tree is believed to be present on Guam, located near Ritidian Point on the upper plateau (located on Andersen AFB). In 1992, super typhoon Omar killed one mature tree on Guam (also on Andersen AFB), but five wild seedlings were observed near the felled native adult. Protective fencing was erected around the seedlings in an effort to protect them from feral ungulates, but by 1994 only one seedling had survived (U.S. Fish and Wildlife Service 1994). In 2002, super typhoon Pongsona partially uprooted this young tree. This tree suffered regular heavy herbivory from butterfly larvae (an unidentified yellow butterfly with green larvae). As of 2011, this tree was not alive (U.S. Department of the Navy 2013a).

In the 1990s, the University of Guam planted 50 seedlings within Area 50 on Andersen AFB; none are known to have survived. In 1999, 20 *Serianthes* tree seedlings from Rota were planted as a joint effort by USFWS, University of Guam, and Andersen AFB in limestone forest along a utility access road in Tarague Basin. Each seedling was protected from ungulate browsing with a wire enclosure. As of 2010, four of the original 20 seedlings survive, surrounded by a wire exclosure fence. As many as five *Serianthes* trees could survive on the Island of Guam as of 2010 (U.S. Department of the Navy 2013a).

3.10.2.3.1.3 Biology, Ecology, and Behavior

New leaves are produced continually throughout the year, but production is sensitive to the dry season (January to June), a time when most branches are dormant. Mature seed pods on Rota were reported during all seasons, and seed crops can be large, with 500 to 1,000 pods (U.S. Fish and Wildlife Service 1994). The age and size necessary for reproduction is unknown, but flowers and pods were seen on a tree known to be 10 years old with a diameter of 7.5 inches (in.) (19.1 centimeters [cm]). On Rota, Mariana fruit bats were observed to feed on *Serianthes* flowers, which may be a method of pollination; however, the most important pollinators are likely birds (U.S. Fish and Wildlife Service 1994).

3.10.2.3.1.4 Status within the Mariana Islands Training and Testing Study Area

As discussed above, the last mature *Serianthes* tree on Guam is located at on the upper plateau above Ritidian Point on Andersen AFB, and as of 2010, another four immature trees are located in Tarague Basin (also on Andersen AFB) (U.S. Department of the Navy 2013a). On Rota, the trees are located in mature limestone forests along cliffline forests of the Sabana region, where training activities do not occur.

3.10.2.3.2 *Nesogenes rotensis* (No Known Common or Local Name)

3.10.2.3.2.1 Status and Management

Nesogenes rotensis is a low-growing herbaceous (non-woody) plant with small, opposite, broadly lance-shaped, coarsely toothed leaves, restricted to Rota. *Nesogenes rotensis* was listed as endangered on April 8, 2004 (FR 04-7934). No critical habitat is designated for this species.

3.10.2.3.2.2 Population and Abundance

One population of fewer than 100 plants was reported in 1982 at the Poña Point Fishing Cliff public park land, owned by and under the jurisdiction of the CNMI Division of Forestry and Wildlife (U.S. Fish and Wildlife Service 2006c). In 1994, Raulerson and Rinehart (1997) recorded a population of about 20 plants, occupying 240 square yards (yd.^{2}) (200 square meters [m^2]) of habitat at the Poña Point Fishing Cliff. Biannual surveys for this species have been conducted since 2001 at Poña Point Fishing Cliff. A direct count was made on June 27, 2000. At that time there were 80 individuals within an approximate area of 960 yd.^{2} (800 m^2). In May and November 2001, direct counts made by staff from the CNMI Division of Forestry and Wildlife identified 458 and 579 adult plants, respectively. No individuals plants were observed in May or November of 2003 following super typhoon Pongsona, but subsequent surveys in 2005 found 20 individual plants (U.S. Fish and Wildlife Service 2006c).

3.10.2.3.2.3 Biology, Ecology, and Behavior

Little is known of the life history or ecology of *Nesogenes rotensis*. Based on information from collections and observations, *Nesogenes rotensis* flowers in March, April, May, and November (Raulerson and Rinehart 1997). It was observed in fruit in January, March, and November (Raulerson and Rinehart 1997). All available information and recent observations suggest that these plants are perennials, but their above-ground parts die back annually (U.S. Fish and Wildlife Service 2006c).

3.10.2.3.2.4 Status within the Mariana Islands Training and Testing Study Area

The current distribution of this plant is restricted to Poña Point Fishing Cliff. The Navy does not train in this area. Threats to *Nesogenes rotensis* include typhoons; ungulate impacts associated with herbivory, trampling, rooting; disease; decreased genetic variability; and pests.

3.10.2.3.3 *Osmoxylon mariannense* (No Known Common or Local Name)

3.10.2.3.3.1 Status and Management

Osmoxylon mariannense is a spindly, soft-wooded tree in the ginseng family, which can reach 33 ft. (10 m) in height. *Osmoxylon mariannense* was listed as endangered on 8 April 2004 (FR 04-7934). No critical habitat is designated for this species.

3.10.2.3.3.2 Population and Abundance

This species is endemic to Rota. Currently, there are eight known wild individuals of this species, occurring along unimproved roads crossing the top of the Sabana Plateau. This distribution is possibly an artifact of limited access for surveys, as large areas of the Sabana away from the roads are difficult or dangerous to survey due to natural topography and large, often hidden holes left from abandoned mining activities. An unknown number of trees currently exist in cultivation, and two trees that were outplanted in 2002 adjacent to wild individuals of *Osmoxylon mariannense* continue to survive, bringing the total number of currently known individuals in the wild to 10.

3.10.2.3.3.3 Biology, Ecology, and Behavior

Little is known of the life history or ecology of *Osmoxylon mariannense*. It occurs as an understory species in mixed ocshal forests (limestone forests with *Hernandia labyrinthica* and *Pisonia umbellifera* dominating), and is often hard to see until some trunks are tall enough to mingle with the trunks of the other two species (Raulerson and Rinehart 1997). There are conflicting reports about the habitat requirements of *Osmoxylon mariannense.* The seeds of *Osmoxylon mariannense* are difficult to germinate, which may be due to production of “false seeds” (structures that appear to be seeds) or low viability rates (U.S. Fish and Wildlife Service 2006c).

3.10.2.3.3.4 Status within the Mariana Islands Training and Testing Study Area

Threats to *Osmoxylon mariannense* include habitat degradation due to ungulate herbivory, decreased genetic diversity, disease, and pests. No training activity on Rota overlaps with the Sabana.

3.10.2.3.4 Mariana Swiftlet/Yayaguak (*Aerodramus bartschi*)

3.10.2.3.4.1 Status and Management

The Mariana swiftlet was listed as endangered on 27 August 1984 (49 FR 33881-33885). No Critical Habitat for this species is designated.

3.10.2.3.4.2 Population and Abundance

The Mariana swiftlet occurs on Guam (in three known caves within the Naval Base Guam Munitions Site), Aguiguan Island (in nine known caves), and Saipan (10 known caves), and the swiftlet is considered extirpated from Tinian and Rota (Cruz et al. 2008). The swiftlet was once thought to be very abundant on Guam. Rota was once thought to support large populations of swiftlets, as evidenced by prehistoric guano and bone deposits, persistent unused nests, and ethnographic reports (Steadman 1999).

3.10.2.3.4.3 Biology, Ecology, and Behavior

The Mariana swiftlet nests and roosts in limestone caves with entrances typically as high as at least 6.2 ft. (1.89 m). In suitable caves, nesting occurs in the dark areas (troglic zone), which is facilitated by the swiftlet's ability to echolocate. By nesting in total darkness, the birds escape harassment from visually oriented predators. As a further protection, this swiftlet often selects nest sites on the highest parts of the cave, often choosing clefts in the cave roof, overhanging walls, or stalactites. These caves are occupied throughout the year (U.S. Fish and Wildlife Service 1991).

Nests are cup shaped, constructed of moss or other plant material, and adhered together with saliva. The nesting season lasts between January and July, although it may be year round (Jenkins 1983). A clutch typically consists of only one egg. Incubation period lasts at least 12 days, followed by a long period for fledging to occur, perhaps up to 35 days. Foraging habitat is found in a wide range of areas, but ridge crests and open grassy savanna areas where they capture small insects while flying are favored (U.S. Fish and Wildlife Service 1991). Recent studies involving guano analyses on Aguiguan Island (Valdez et al. 2011) and Saipan and Rota (Kershner et al. 2007) suggest that preferred prey species are members of Hymenoptera, a large order of insects comprising of sawflies, wasps, bees, and flying ants. Flying ants were the dominant prey species identified in guano deposits in swiftlet caves on Aguiguan Island, but the prey species may vary depending on surrounding habitats and seasonal availability of different insect species (Valdez et al. 2011).

3.10.2.3.4.4 Status within the Mariana Islands Training and Testing Study Area

The Mariana swiftlet is known to nest in only three caves on Guam within the Naval Base Guam Munitions Site (Mahlac, Maemong, and Fachi caves), as shown on Figure 3.10-5. The Navy, USFWS, and Guam Division of Aquatic and Wildlife Resources have been monitoring the populations at these caves for 23 years (U.S. Department of the Navy 2013a). The Mariana swiftlet has maintained a small population of about 400 to 500 birds through the 1980s and 1990s. Although small fluctuations in the population have been documented during this period, there was no significant growth. Brown treesnake traps were initially deployed outside Mahalac cave in 2000. Declines of swiftlet numbers were noted after major typhoon events, the last major typhoon to hit Guam and the CNMI was Typhoon Pongsona in 2002 (U.S. Department of the Navy 2013a). The population of Mariana swiftlets appears to be increasing, as shown on Figure 3.10-6. The population in 2012 was estimated to be between 1,100 and 1,500 birds. Swiftlet populations on Saipan are also increasing, and brown treesnakes are not believed to be present in those caves. The general location of the known swiftlet caves on Saipan are shown on Figure 3.10-7.

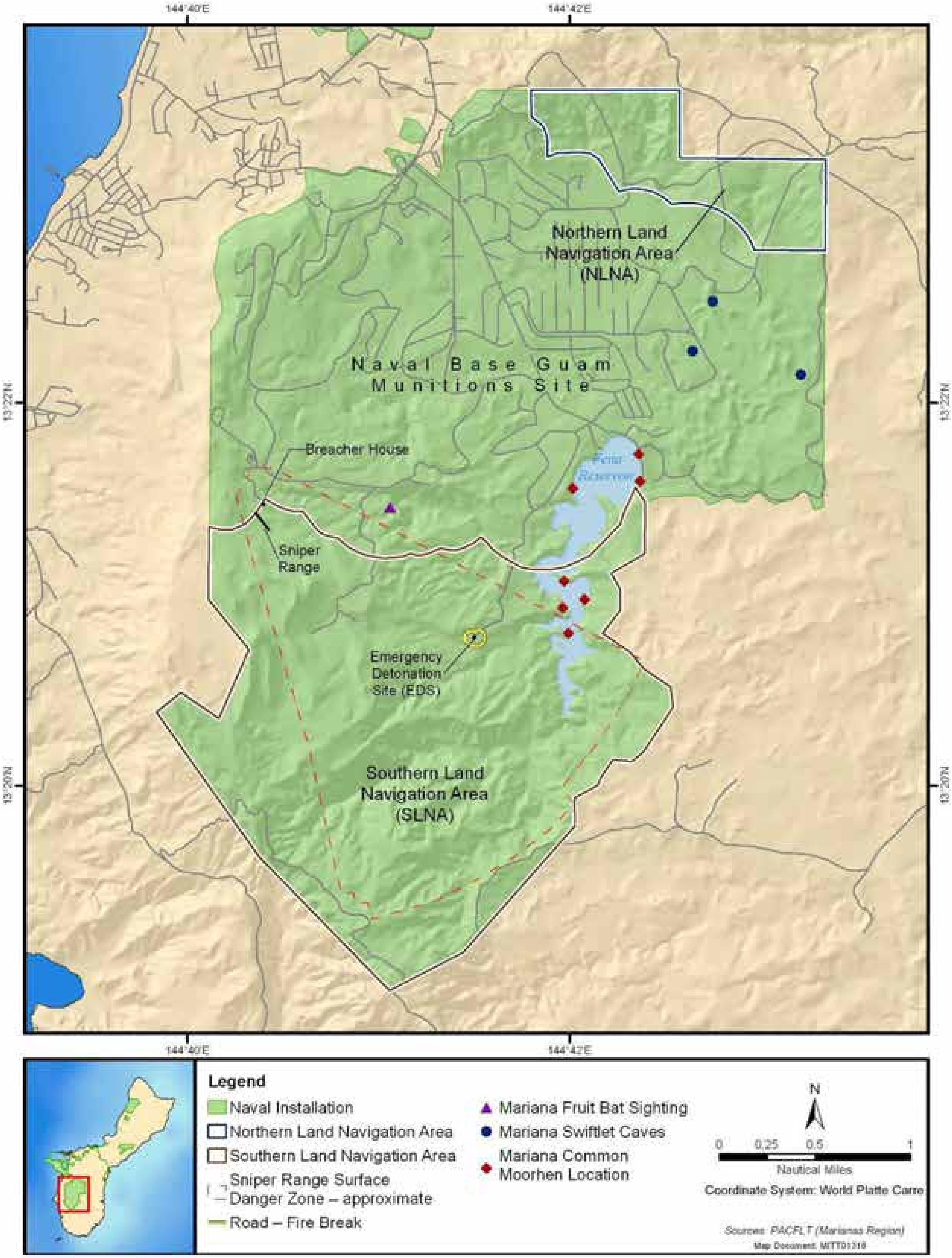
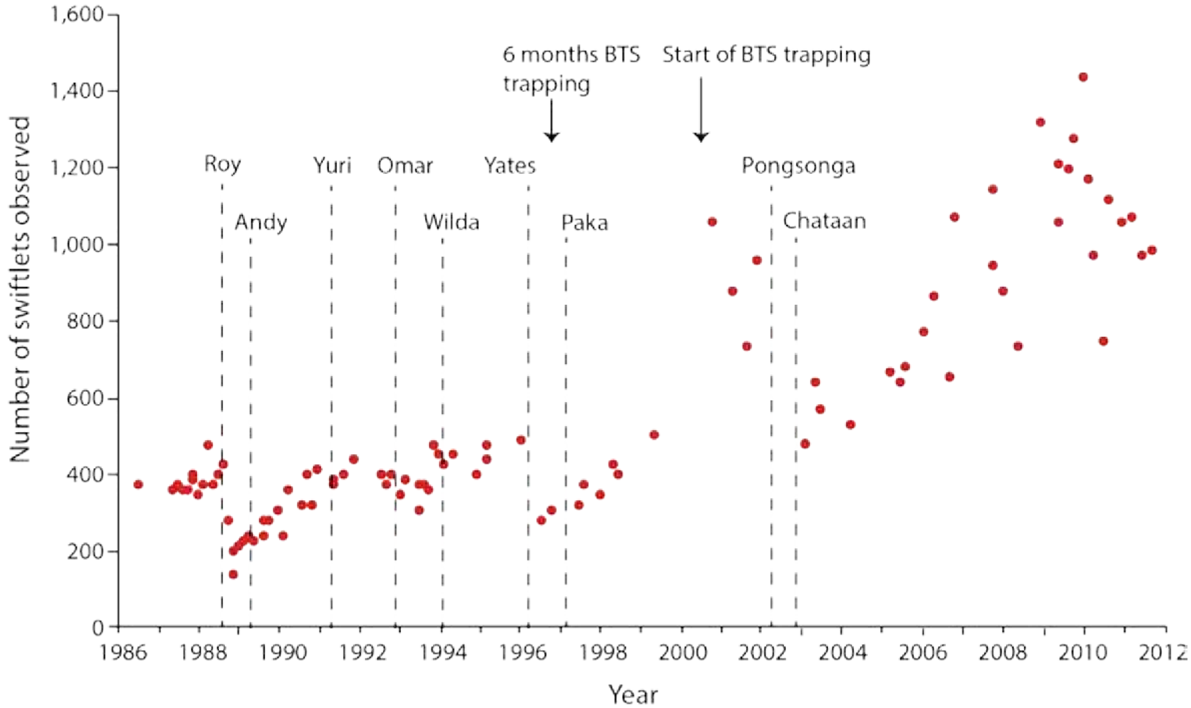


Figure 3.10-5: Naval Munitions Site and Mariana Swiftlet Cave Locations



Notes: (1) Typhoons are shown on the graph where wind speeds were measured on Guam to be greater than 100 mph. (2) Typhoon occurrences and swiftlet data are indexed to Fiscal Years, beginning in October.

Figure 3.10-6: Mariana Swiftlet Population Data from Mahlac Cave, Naval Munitions Site, 1986–2012

3.10.2.3.5 Mariana Crow/Aga (*Corvus kubaryi*)

3.10.2.3.5.1 Status and Management

The Mariana crow was listed as endangered on 27 August 1984 (49 FR 33881-33885). On 28 October 2004, approximately 376 ac. (152.2 ha) were designated as Critical Habitat for the Mariana crow on Guam, and 6,033 ac. (2,441.5 ha) were designated on Rota (69 FR 629446). All Critical Habitat for the species on Guam is found on the fee simple portion of the Guam National Wildlife Refuge.

On Guam, its decline is due to predation by the introduced brown treesnake. On Rota, recent typhoons have devastated forest habitat, and forest has been cleared for homestead development, resort and golf-course construction, and agricultural settlement. Additional threats include nest predation, disturbance by introduced species and feral cats, and disease (U.S. Department of the Navy 2013a).

3.10.2.3.5.2 Population and Abundance

The distribution of Mariana crows among habitats is similar on Guam and Rota. Mariana crows are known to use secondary, coastal, ravine, and agricultural forests, including coconut plantations (Jenkins 1983), but all evidence indicates they are most abundant in native limestone forests (Michael 1987; Morton 1996).

On Rota, breeding crows on six study areas averaged one pair per 50 ac. (20.2 ha) of forested habitat, and each territory was dominated by native forest (U.S. Fish and Wildlife Service 2006b, 2009a). Pair densities ranged from one per 91 ac. (36.8 ha) in relatively fragmented forest, to as high as one pair per 30 ac. (12.1 ha) in mostly intact limestone forest along a coastal terrace. Territories were aggressively defended from July through January, although established pairs occupied these areas throughout the year.

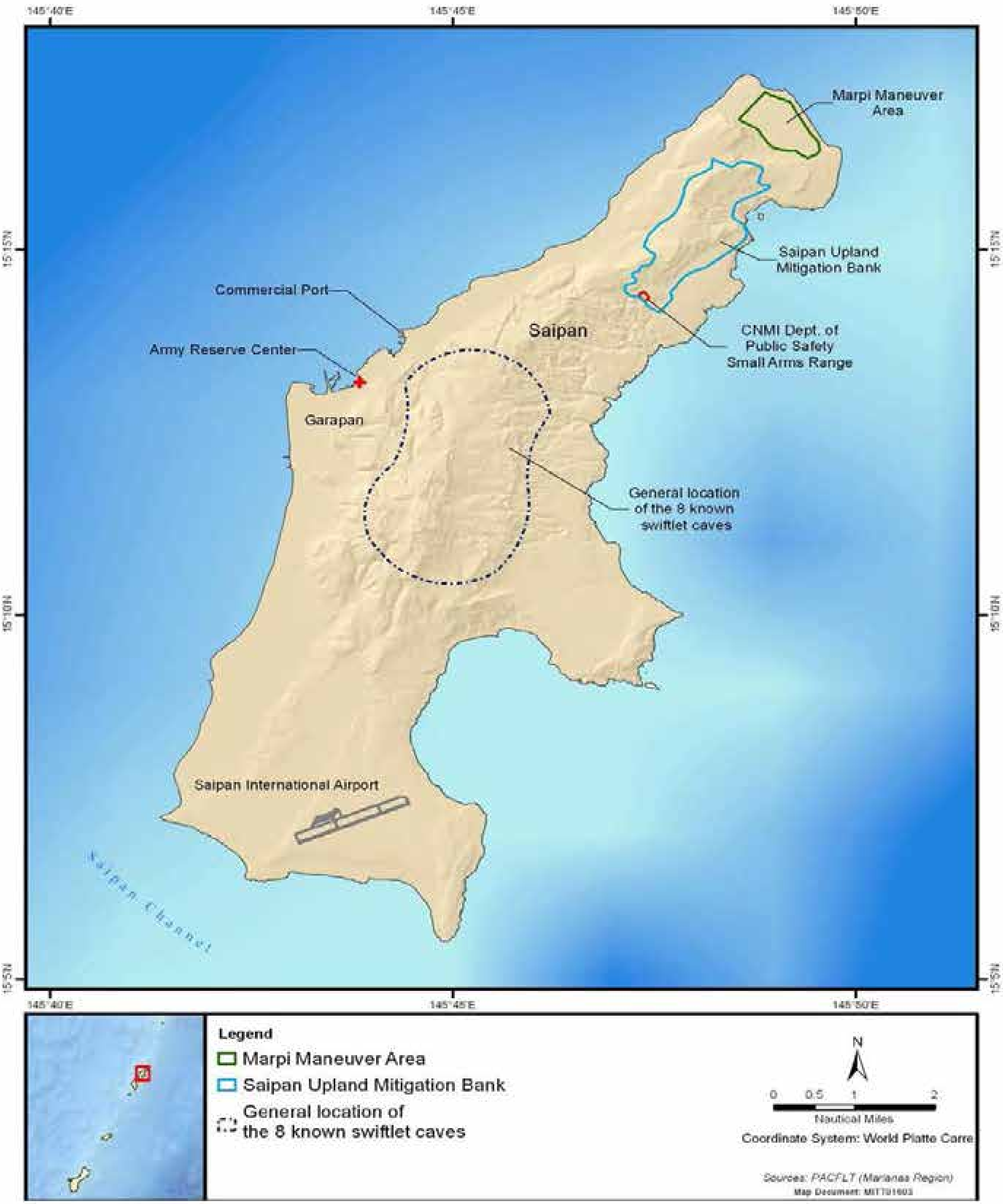


Figure 3.10-7: General Location of Mariana Swiftlet Caves on Saipan

3.10.2.3.5.3 Biology, Ecology, and Behavior

Mariana crows are omnivorous and forage at all heights in the forest and on the ground. They are observed feeding on a variety of native and non-native invertebrates, reptiles, young rats, and birds' eggs, as well as on the foliage, buds, fruits, and seeds of at least 26 plant species (Jenkins 1983; Michael 1987; Tomback 1986). Mariana crow nests on Guam were found in 11 tree genera, all but one of which are native. Most nests are located high in emergent nunu or yoga trees (Morton 1996). On Rota, crows primarily use both mature and secondary limestone forests. Of 156 nest sites on Rota, 39 percent and 42 percent were in mature and secondary limestone forest, respectively. Individual nest trees averaged 6.7 in. (17.02 cm) diameter at breast height and 28.5 ft. (8.69 m) high. Canopy cover over nest sites averaged 93 percent and was never less than 79 percent. Nests were located at least 950 ft. (289.6 m) from the nearest road and 203 ft. (61.9 m) from the nearest forest edge, in areas with forest canopy cover that averaged 93 percent. The distances from edges strongly suggest that nesting crows are sensitive to disturbance by humans.

Mariana crows likely breed year round. However, peak nesting occurs between August and February on Rota and October and April on Guam (Morton 1996). Both parents generally participate in building the nest, incubating the eggs, and rearing the chicks through fledging. Nest construction typically takes a week, and the incubation and nestling periods are between 21 to 23 days and 36 to 39 days, respectively. In general, Mariana crows only produce a single brood a year but nest failure and other factors lead to multiple nest attempts. On Rota, 32 pairs constructed an average of two nests a year and nested up to seven times in one season. After fledging, Mariana crows will typically remain in family groups until the following breeding season, but fledgling attendance can vary from 99 to 537 days.

3.10.2.3.5.4 Status within the Mariana Islands Training and Testing Study Area

As of February 2009, two Mariana crows remained at Andersen AFB Munitions Storage Area, both male (U.S. Department of the Navy 2013a). As of July 2011, a single male Mariana crow remained on Andersen AFB. This last remaining crow was last seen in August 2011. Continuing surveys have not located the crow again, and natural resource specialists on Guam believe the Mariana crow has been extirpated from Guam (SWCA Environmental Consultants 2012). Mariana crows on Rota are located in mature limestone forest areas of the island where training activities do not occur.

3.10.2.3.6 Mariana Common Moorhen/Pulattat (*Gallinula chloropus guami*)

3.10.2.3.6.1 Status and Management

The Mariana common moorhen was listed as endangered in 1984 (49 FR 33881-33885). No Critical Habitat is designated for this species.

The main threat to this species is loss and degradation of wetland habitat, including filling, alteration of hydrology, invasion of habitat by nonnative plants, and unrestricted grazing. The second-greatest threat is predation by introduced species. Other natural or manmade factors that threaten the species are environmental contaminants and fires (U.S. Department of the Navy 2013a).

3.10.2.3.6.2 Population and Abundance

The Mariana common moorhen was historically restricted to wetland areas of Guam, Saipan, Tinian, and Pagan, the only islands within the Marianas supporting sufficient wetlands capable of supporting the Mariana common moorhen. Major wetland areas of Guam apparently supported substantial populations, particularly marshes, taro patches, and rice fields. The greatest historical concentrations on Guam appeared to be in Agana Swamp, along the Ylig River in southern Guam. Other large populations in the Commonwealth of the Northern Mariana Islands were associated with Hagoi on Tinian and Lake

Susupe on Saipan (Takano and Haig 2004). The Pagan population is believed to be extirpated due to ash and cinder fallout from a 1981 eruption of Mount Pagan, as well as ungulate impacts to wetland vegetation. Paleobiological evidence suggests that moorhens occurred in prehistoric times on Rota approximately 1,500 to 2,000 years ago (Steadman 2009). The prehistoric extirpation of this species from Rota has been attributed to draining of wetlands, natural degradation of wetlands over time due to sea level changes (Stinson et al. 1991), and hunting and predation by introduced predators (Stinson et al. 1991).

3.10.2.3.6.3 Biology, Ecology, and Behavior

Breeding is assumed to occur year-round for the Mariana common moorhen, as nests were located in all months except for October (Takano and Haig 2004). Similar subspecies in Hawaii build nests by folding over emergent vegetation into a platform nest. Apparently, vegetation structure is more important than species composition for nest construction and nest location, and nesting is apparently associated with water depth and availability of screening vegetation (Jenkins 1983; U.S. Fish and Wildlife Service 1990).

Clutch sizes of four to eight eggs for the Mariana common moorhen are recorded, although clutch sizes of similar subspecies were observed as high as 13 eggs. Incubation lasts approximately 22 days, and chicks hatch precocial and swim away from the nest shortly after hatching, but remain dependent on the parent birds for several weeks.

3.10.2.3.6.4 Status within the Mariana Islands Training and Testing Study Area

A survey of Mariana common moorhens on Guam was conducted in 2001 (Takano and Haig 2004). Three wetlands in Naval Base Guam Munitions Site were surveyed, including Fena Reservoir, Fena Dam spillway, and the Naval Magazine Pond. Surveys were conducted during the dry season when Mariana common moorhens were expected to be more concentrated on perennial wetlands and therefore easier to count. Of the 90 birds estimated to be on Guam during the survey, 38 birds were located on wetlands in the Naval Base Guam Munitions Site, 33 of which were using Fena Reservoir. Since 2001, eutrophication of Fena Reservoir following a typhoon resulted in the loss of *Hydrilla verticillata*, a non-native water plant used by moorhens as a nesting substrate. The Mariana common moorhen population at the reservoir subsequently declined dramatically (U.S. Fish and Wildlife Service 2010a).

Wetland habitat suitable for the Mariana common moorhen exists on Naval Base Guam Main Base. Moorhens are known to occupy these wetlands at least during the wet season and possibly also in the dry season if open water habitat remains present. Two Mariana common moorhens were observed at the San Luis Ponds during a recent survey in 2010 and 2011. Moorhens are not known to nest at any of the wetlands on Naval Base Guam. The Camp Covington wetland on Naval Base Guam was identified as a habitat requiring species-specific surveys to determine whether the Mariana common moorhen is present. Eleven listening survey stations were placed within the Camp Covington wetland during a 2009 endangered species survey. Moorhens were observed nesting in the Camp Covington wetland area in 2012 (U.S. Department of the Navy 2013a).

Since the construction of an 18-hole golf resort on the north coast of Rota in the early 1990s, moorhens have colonized polishing ponds associated with waste water treatment infrastructure for the resort. The polishing ponds contain suitable nesting habitat. Successful nesting was confirmed in 1996 (Worthington 1998). These areas are not used for military training activities.

On Tinian, monitoring surveys began at Hagoi in 1998 and are performed (generally) on a monthly basis at the end of each month. As index surveys, the surveys document population trends over time, but do not estimate the number of animals in the population. Yearly averages of the monthly monitoring program show that 2003, 2007, and 2011 were peak years for Mariana common moorhen numbers at Hagoi (16.9, 17.1, and 15.7, respectively), and troughs during 1999 and 2005 (10.1 and 9.9, respectively). The number of birds observed appears to correlate to periodic dry conditions at the Hagoi wetland (Hagoi was completely dry in April 2005 and in 2010); however, it is unknown if the apparent fluctuation in Mariana common moorhen numbers observed at Hagoi reflect true population changes, emigration or immigration, or observer bias (U.S. Department of the Navy 2008d, 2013). Nest locations for moorhens on Tinian for 2011 and 2012 survey seasons are shown on Figure 3.10-8.

3.10.2.3.7 Guam Micronesian Kingfisher/Sihek (*Todiramphus cinnamomina cinnamomina*)

3.10.2.3.7.1 Status and Management

The Guam Micronesian kingfisher was listed as endangered on 27 August 1984 (49 FR 33881-33885). On 28 October 2004, approximately 376 ac. (152.2 ha) on Guam were designated as Critical Habitat for the Guam Micronesian kingfisher (69 FR 629446). All Critical Habitat for this subspecies is found on the fee simple portion of the Guam National Wildlife Refuge.

3.10.2.3.7.2 Population and Abundance

This subspecies of the Guam Micronesian kingfisher (*Todiramphus cinnamomina cinnamomina*) is endemic to Guam. The other two subspecies occur on the islands of Pohnpei (*Todiramphus cinnamomina reichenbachii*) and Palau (*Todiramphus cinnamomina pelwensis*). The Guam Micronesian kingfisher was considered “fairly common” and occurred throughout forested areas on Guam shortly after World War II (Jenkins 1983). Populations in southern and central Guam disappeared by the 1980s (Jenkins 1983) and only 3,023 individuals were recorded in 1981 in northern Guam (U.S. Fish and Wildlife Service 2008b). This population subsequently declined rapidly, and by 1985 only 30 individuals were recorded on Guam (U.S. Fish and Wildlife Service 2008b). This subspecies was believed extirpated by 1988, primarily because of predation by the brown treesnake (Fritts and Leasman-Tanner 2001; U.S. Fish and Wildlife Service 2008b). Guam Micronesian kingfishers survive in captive programs that seek to breed kingfishers and maintain the population until habitats are suitable for reintroduction. GovGuam Division of Aquatic and Wildlife Resources, as well as various zoos in the United States, maintain kingfishers in captivity.

3.10.2.3.7.3 Biology, Ecology, and Behavior

The Guam Micronesian kingfisher feeds both on invertebrates and small vertebrates, including insects, segmented worms, hermit crabs, skinks, geckoes, and possibly other small vertebrates (Jenkins 1983). This species typically forages by perching motionless on exposed perches and swooping down to capture prey on the ground (Jenkins 1983). Guam Micronesian kingfishers also will capture prey from foliage and were observed gleaning insects from tree bark (U.S. Fish and Wildlife Service 2008b).

This subspecies nests in cavities, and breeding activity appears to be concentrated from December to July (Jenkins 1983). Nests are reported in a variety of trees, including nunu*, Cocos nucifera, Artocarpus* spp., umumu, and fai’a (Jenkins 1983; U.S. Fish and Wildlife Service 2008b). Pairs may excavate their own nests in soft trees, arboreal termite nests, arboreal fern root masses, or they may utilize available natural cavities such as broken tree limbs (U.S. Fish and Wildlife Service 2008b), and excavation of cavities may be important in pair-bond formation and maintenance (Jenkins 1983).

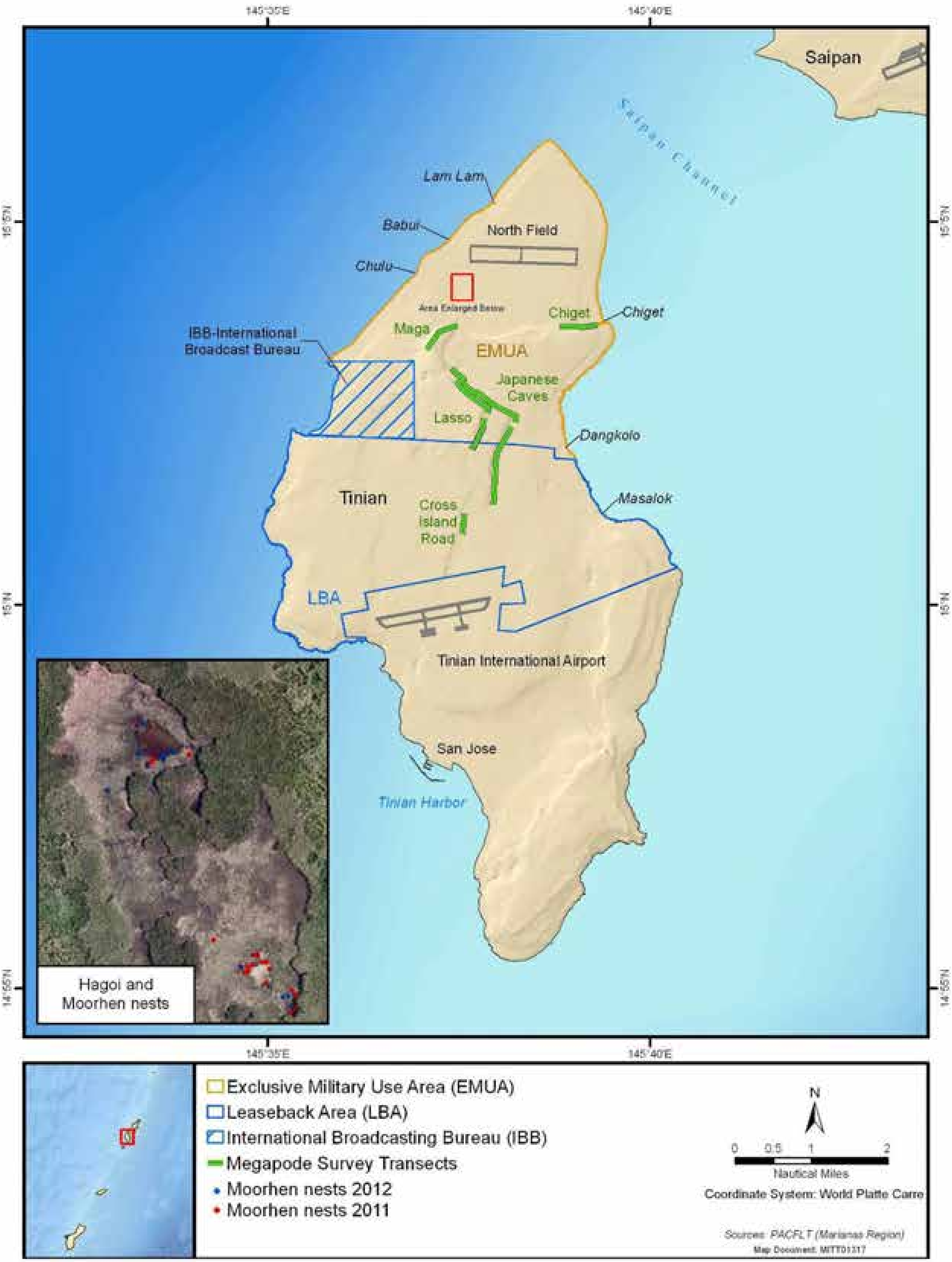


Figure 3.10-8: Tinian Military Lease Area and Mariana Common Moorhen Nest Locations

Both male and female Guam Micronesian kingfishers incubate eggs and brood and feed nestlings (Jenkins 1983). Clutch sizes from wild populations were either one or two eggs (Jenkins 1983) while clutch sizes of one to three eggs are reported in the captive populations (U.S. Fish and Wildlife Service 2008b). Incubation, nestling, and fledgling periods for populations of Guam Micronesian kingfishers in the wild are unknown. However, incubation and nesting periods of captive birds averaged 22 and 33 days, respectively (U.S. Fish and Wildlife Service 2008b).

Jenkins (1983) reported that the Guam Micronesian kingfisher nest and feed primarily in mature, secondary growth, and, to a lesser degree, in scrub limestone forest. It is also found in coastal strand vegetation containing coconut palm as well as riparian habitat. However, Jenkins (1983) reported that it was probably most common along the edges of mature limestone forest. Few data exist about specific kingfisher nest sites in the wild, but in one study in northern Guam 16 nest sites were correlated with closed canopy cover and dense understory vegetation. In this study, nest cavities were excavated in the soft, decaying wood of large, standing dead trees averaging 17 in. (43.2 cm) in diameter (U.S. Fish and Wildlife Service 2008b). Research on the Pohnpei Micronesian kingfisher indicates an area of approximately 20 to 25 ac. (8.1 to 10.1 ha) of mixed forest, and open area may be needed to support a pair of kingfishers. It should be noted that Micronesian kingfisher territories may differ from Pohnpei Micronesian kingfisher territories due to differences in forest structure on Guam and Pohnpei (Mueller-Dombois and Fosberg 1998).

3.10.2.3.7.4 Status within the Mariana Islands Training and Testing Study Area

The Guam Micronesian kingfisher is currently extirpated and is not found in the Study Area.

3.10.2.3.8 Micronesian Megapode/Sasangat (*Megapodius laperouse laperouse*)

3.10.2.3.8.1 Status and Management

The Micronesian megapode was first listed as endangered in 1970 (under the Endangered Species Conservation Act, 35 FR 8491-8498). No Critical Habitat is designated for this species. Threats to this species include habitat loss from typhoons and volcanic activity, damage by feral herbivores, historical hunting and illegal egg collection, increased tourism, and predation by introduced predators (U.S. Department of the Navy 2013a).

3.10.2.3.8.2 Population and Abundance

Small remnant populations are known to exist on the southern Mariana Islands of Aguiguan, Saipan, and FDM; larger populations are reported on uninhabited northern islands of Anatahan, Guguan, Sarigan, Alamagan, Pagan, Asuncion, Maug, and possibly Agrihan (U.S. Fish and Wildlife Service 1998, U.S. Department of the Navy 2013a). Megapodes observed on Tinian are believed to be transient and do not breed on Tinian (U.S. Department of the Navy 2013a, 2013b).

3.10.2.3.8.3 Biology, Ecology, and Behavior

Micronesian megapodes are generally dependent on native limestone forest, but may occasionally use native and non-native secondary forest adjacent to limestone forest. Micronesian megapode primarily select nest sites in sun-warmed cinder fields on volcanic islands and exposed limestone flats, but may nest in roots of rotting trees, logs, and in patches of rotting sword grass. The breeding season for Micronesian megapodes is reported on Saipan to begin in November and last through December, although the season may be year-round (U.S. Fish and Wildlife Service 1998). Megapodes are considered "incubator" birds because they rely on external energy sources, such as solar heat, volcanic activity, or heat produced from microbial decomposition of organic matter as heat sources for incubation. Multiple eggs are laid singly in a breeding season, each egg is laid after an interval of approximately 1 week.

Chicks emerge from nests super-precocial and able to function (and fly) independent of the parent birds (U.S. Fish and Wildlife Service 1998).

3.10.2.3.8.4 Status within the Mariana Islands Training and Testing Study Area

Surveys on FDM in 1996 documented the presence of the Micronesian megapode (Lusk et al. 2000; U.S. Fish and Wildlife Service 1998). From this survey, it was estimated that a population of 10 Micronesian megapodes were on FDM (Kessler and Amidon 2009; Lusk et al. 2000; U.S. Fish and Wildlife Service 1998). However, due to an incoming typhoon, biologists were only on the island for about 5.5 hours, so this estimate was based on limited data. FDM was surveyed more thoroughly in December 2007 by Navy biologists, which provided an estimate of 21 adult pairs (U.S. Department of the Navy 2008a, c). Mitigation measures specified in previous consultations coupled with the restricted access preventing poaching activities, may have benefited megapodes on FDM. The mitigation measures included maintaining a no fire zone on the northern portion of the island and the use of inert ordnance in an area south of the no fire zone (explosive ordnance is deployed to the south of this area).

On Tinian, Micronesian megapodes have been previously reported but never in great numbers (O'Daniel and Kreuger 1999; U.S. Department of the Navy 2008a, d). Micronesian megapodes have been sighted on Tinian within forested portions of the Maga area to the northeast of the Voice of America Relay Station, a small section of native forest adjacent to Cross Island Road in the Bateha area and the Mount Lasso area south of the overlook on the ridgeline (O'Daniel and Kreuger 1999). Based on these sightings and other suitable habitat indicators, the Navy established monitoring transects in 1999, which were surveyed on a monthly basis through 2012 using point count stations (where trained observers listened for responses to recorded megapode vocalizations). These surveys are now conducted on an annual basis (U.S. Department of the Navy 2013a). One megapode was observed on Tinian during recent annual surveys in February 2013. Prior to this detection, one megapode was observed in February 2004 and two others in June 2005 by biologists transiting between point count stations (U.S. Department of the Navy 2013a).

3.10.2.3.9 Guam Rail/Ko'ko' (*Rallus owstoni*)

3.10.2.3.9.1 Status and Management

The Guam rail was listed as endangered on 27 August 1984 (49 FR 33991-33885). No Critical Habitat for this species has been designated for the Guam rail. An experimental population has been established on Rota since reintroductions began in the late 1980s on the Sabana Plateau and in the I'Chinchon Bird Sanctuary. The USFWS has designated Guam rails released on Rota as a "nonessential experimental population," where the released rails on Rota are nonessential to the continued existence of the species. Members of a nonessential experimental population are treated as a species proposed for ESA listing. In other words, federal agencies are not required to consult with the USFWS pursuant to Section 7(a)(2) of the ESA for potential impacts to Guam rails on Rota, and are only required to confer with the USFWS if a proposed action is likely to jeopardize the continued existence of the Guam rail. A Safe Harbor Agreement was established in 2008 on Cocos Island to allow for management actions and reintroductions of Guam rails on Cocos Island.

3.10.2.3.9.2 Population and Abundance

The Guam rail is endemic to Guam. This species was once distributed throughout Guam but by 1981 a population of approximately 2,300 birds existed only in northern Guam (U.S. Fish and Wildlife Service 1990). In 1983, it was estimated that fewer than 100 individuals remained and it was considered extirpated by 1987 (Beauprez and Brock 1999). A captive breeding program began in 1983, which relocated individuals from the wild to breeding facilities on Guam (Guam Division of Aquatic and Wildlife

Resources 2006). As of 2005, 173 individuals were found in captivity in zoological institutions on the U.S. mainland and Guam Division of Aquatic and Wildlife Resources captive propagation facilities (Guam Division of Aquatic and Wildlife Resources 2006; U.S. Fish and Wildlife Service 2006a). In addition, Guam Division of Aquatic and Wildlife Resources is releasing rails on Cocos Island (off southern Guam). Efforts to establish an experimental population on the island of Rota have been underway since 1989 (Beauprez and Brock 1999). The current population on Rota is estimated to be approximately 40 to 70 individuals (U.S. Department of the Navy 2013a; U.S. Fish and Wildlife Service 2006a). Releases of rails on Cocos Island and Rota were preceded by predator eradication and reduction programs (e.g., removal of rats and monitor lizards) at release sites (Brooke 2012).

3.10.2.3.9.3 Biology, Ecology, and Behavior

Guam rails are territorial ground nesters that breed year-round (Jenkins 1983); however, peak breeding may occur during the rainy season (July through November) (U.S. Fish and Wildlife Service 1990). Clutches typically consist of three to four eggs and broods range from one to four chicks. Guam rails are omnivorous but appear to prefer animal matter over vegetable foods. They are known to eat gastropods, skinks, geckos, insects, carrion, seeds, and palm leaves. This species is believed to prefer secondary vegetation, although it was found in all habitats except wetlands, and savanna and mature forest may be marginal habitats (Jenkins 1983).

3.10.2.3.9.4 Status within the Mariana Islands Training and Testing Study Area

There are no Guam rails currently located at Andersen AFB, or on any other DoD property.

3.10.2.3.9.5 Nightingale Reed-Warbler/Ga'ga' Karisu (*Acrocephalus luscinia*)

3.10.2.3.9.6 Status and Management

The nightingale reed-warbler was listed as endangered on 2 June 1970 (35 FR 8491-8498). The Saipan Upland Mitigation Bank was established in 2004 to provide perpetual conservation and management for endangered nightingale reed-warbler and other native species within the bank boundaries (Herod and William 2008). Further, the Saipan Upland Mitigation Bank is a mitigation option for eligible projects that will result in unavoidable impacts to the nightingale reed-warbler. Past and present threats to this species include loss and degradation of habitat (including wetland destruction and degradation due to feral ungulates); predation by introduced predators such as the brown treesnake, rats, and monitor lizard; and volcanic activity (U.S. Fish and Wildlife Service 2010b).

3.10.2.3.9.7 Biology, Ecology, and Behavior

The nightingale reed-warbler may be characterized as a secretive species that prefers screening provided by dense underbrush. Like many warbler species, the male is vocal and aggressive toward conspecific intruders. Mosher and Fancy (2002) observed two peak breeding periods from January through March (dry season) and from July through September (wet season), and active nests were found in all months except November and December.

Most birds found on Saipan occur in thicket-meadow mosaics, forest edge, reed-marshes, and forest openings, and are largely absent from mature native forest, beach strand, and swordgrass vegetation community types (Camp et al. 2009). Nightingale reed-warblers were observed to prey on insects by gleaning invertebrates from live and dead leaves (Craig 1992). Other food sources include snails and lizards (Marshall 1949).

3.10.2.3.9.8 Status within the Mariana Islands Training and Testing Study Area

Marpi Maneuver Area on Saipan contains suitable habitat for the nightingale reed-warbler. Craig (1992) surveyed the Marpi area and detected reed-warblers in areas, including the Marpi Maneuver Area.

3.10.2.3.10 Rota Bridled White-Eye/Nosa Luta (*Zosterops rotensis*)

3.10.2.3.10.1 Status and Management

The Rota bridled white-eye was listed as endangered on 22 January 2004 (69 FR 3022–3029). The Rota bridled white-eye has critical habitat designated on Rota (2,594 ac. [1,050 ha]). Current threats include habitat loss and degradation, predation by introduced rats and black drongos (*Dicrurus macrocercus*), and susceptibility of the single small population to random catastrophic events, such as typhoons. In addition, establishment of a new predator, such as the brown treesnake or avian diseases, such as West Nile virus, also threaten recovery of the species (U.S. Fish and Wildlife Service 2006b).

3.10.2.3.10.2 Biology, Ecology, and Behavior

Rota bridled white-eye primarily forage in the outer canopy of forests for insects, fruit, or nectar, and the majority of foraging observations were reported in yoga, nonak, pengua, and ahgao. Rota bridled white-eye nests are reported in fai'a, nonak, yoga, and *Acacia confusa* trees 10 to 49 ft. (3 to 15 m.) tall and 1 to 24 in. (2.5 to 61 cm) in diameter (U.S. Fish and Wildlife Service 2006b).

Breeding was observed between December and August (U.S. Fish and Wildlife Service 2006b). Because this time period covers portions of both the wet season and dry season, the species may breed year round, similar to the Guam bridled white-eye (Marshall 1949; Jenkins 1983). Rota bridled white-eye nests are cup-like and typically suspended between branches and branchlets or leaf petioles (U.S. Fish and Wildlife Service 2006b).

3.10.2.3.10.3 Status within the Mariana Islands Training and Testing Study Area

The Rota bridled white-eye is endemic to Rota. Currently, the species is primarily restricted to mature forests above 490 ft. (150 m) in the Sabana region of Rota. There is no military training in these areas.

3.10.2.3.11 Mariana Fruit Bat/Fanihi (*Pteropus mariannus mariannus*)

3.10.2.3.11.1 Status and Management

The Guam population of the Mariana fruit bat was listed as endangered on 27 August 1984 (49 FR 33881-33885). However, in 2005, the subspecies was listed as threatened throughout the Mariana archipelago and downlisted to threatened on Guam (70 FR 1190-1210). On 28 October 2004, approximately 376 ac. (152.2 ha) were designated as Critical Habitat for the Mariana fruit bat on Guam (69 FR 629446). All Critical Habitat for the species is found on the fee simple portion of the Guam National Wildlife Refuge. Threats to this species include illegally hunting, predation by the brown treesnake, deforestation for development, and overgrazing by introduced species. Random events such as typhoons and volcanic eruptions are also a potential, direct threat to the species (U.S. Fish and Wildlife Service 2009c).

3.10.2.3.11.2 Biology, Ecology, and Behavior

During the day, the Mariana fruit bat roosts in colonies of a few to rarely up to 2,000 animals (Utzurrum et al. 2003); as well as in non-colonial roost sites. Bats are typically grouped into harems (one male and two to fifteen females) or bachelor groups (predominantly males); some single males reside at the colony's periphery (Morton and Wiles 2002). On Guam, the average estimated sex ratio in one colony varied from 37.5 to 72.7 males per 100 females. A smaller number of Mariana fruit bats roost solitarily away from the colony (Janeke 2006). Reproduction in Mariana fruit bats was observed year-round on Guam and on Rota; individual females have a single offspring each year (Pierson et al. 1996). Glass and Taisacan (1988) suggest that the peak birthing season may occur during May and June. Although specific data for the Mariana fruit bat are lacking, other species of bats within the family Pteropodidae have one offspring per year, generally are not sexually mature until at least 18 months of age, and have a gestation period of 4 to 6 months (Epstein et al. 2009). The average lifespan of this species is unknown; the average longevity of a similar species in Australia is 4 to 5 years, with a maximum of 8 years (Vardon and Tidemann 2000).

Colonial roost sites are an important aspect of the Mariana fruit bat biology because they are used for sleeping, grooming, breeding, and intra-specific interactions (Wiles et al. 1989). Published reports of roost sites on Guam indicate these sites occur in mature limestone forest and are found within 328 ft. (100.0 m) of 262 to 591 ft. (79.9 to 180.1 m) tall clifflines. Native forest habitat is also an important aspect of Mariana fruit bat biology as it is also used for roosting, feeding, etc., by non-colonial Mariana fruit bats. On Guam, Mariana fruit bats roost in mature nunu and chopak trees but will also roost in other tree species such as gago, pengua (*Macaranga thompsonii*), panao, and fagot. On other islands in the Mariana archipelago, Mariana fruit bats were observed in secondary forest and gago groves (Glass and Taisacan 1988). Factors involved in roost site selection are not clear, but data from Guam indicate that some sites may be selected for their inaccessibility by humans and thus limited human disturbance. Mariana fruit bats will abandon roost sites if disturbed and are reported to move to new locations up to 6 mi. (9.7 km) away (U.S. Fish and Wildlife Service 1990).

Several hours after sunset, Mariana fruit bats depart their roost sites to forage for fruit and other native and non-native plant materials such as leaves and nectar (Janeke 2006; U.S. Fish and Wildlife Service 1990). This species feeds on a variety of plant material but is primarily frugivorous (Wiles et al. 1989). Specifically, Mariana fruit bats forage on the fruit of at least 28 plant species, the flowers of 15 species, and the leaves of two plant species. Some plants used for foraging include dukduk, papaya, *Cycas micronesica*, nunu, kafo, *Cocos nucifera*, and *Terminalia catappa*. Many of these plant species are found in a variety of forested habitats on Guam, including limestone, ravine, coastal, and secondary forests (Donnegan et al. 2004; Raulerson and Rinehart 1991).

3.10.2.3.11.3 Status within the Mariana Islands Training and Testing Study Area

Non-colonial Mariana fruit bat roost throughout Northwest Field, Tarague basin, Jinapsan Beach area, Guam National Wildlife Refuge lands, Naval Communications Site, and private lands in northern Guam. Three solitary Mariana fruit bats were sighted on Navy lands during 90 hours of observations at 14 different survey locations (U.S. Department of the Navy 2008b). Two sightings were on Naval Communications Site, one below the cliff-line in the northern section of the Haputo Ecological Reserve near Falcona, and the other was seen flying westward across Route 3A from Andersen AFB onto Naval Communications Site (U.S. Department of the Navy 2008b). The island-wide population on Guam is likely not to exceed 50 Mariana fruit bats (U.S. Department of the Navy 2013a). The last colony of Mariana fruit bats on Guam was located at Pati Point on Andersen AFB. This colony no longer exists, and Mariana fruit bats persist on Andersen AFB as solitary individuals (SWCA Environmental Consultants 2012).

On Rota, Mariana fruit bats are found in mature limestone forests and coconut groves on the island. Military training activities do not occur in these areas.

On Tinian, few Mariana fruit bats were observed during surveys although island residents report occasionally seeing Mariana fruit bats (U.S. Department of the Navy 2008a). During surveys in 1979, two Mariana fruit bats were observed in the Kastiyu forest and an island-wide estimate of 25 to 100 was based on available forest habitat. Surveys in 1994 and 1995 did not observe Mariana fruit bats; however, two incidental sightings were reported from other locations on Tinian. No Mariana fruit bats were sighted during two surveys in 2000; however, Mariana fruit bats also reside on Aguiguan and travel to Tinian to forage (Cruz et al. 1999, 2000, 2002). In June 2005, approximately five Mariana fruit bats were seen in the cliff-line forest during a routine forest bird survey of the Maga bird transect (U.S. Department of the Navy 2008a). Because of the few numbers of bat observations and the likelihood that Mariana fruit bats observed on Tinian are not residents, the Mariana fruit bat should be considered incidental on Tinian.

FDM may serve as a stopover location for Mariana fruit bats while transiting between islands. Incidental observations of Mariana fruit bats during recent bird surveys, along with fisherman reports from the early 1970s, suggest a small number of Mariana fruit bats use FDM. Use of the island by Mariana fruit bats may have been higher prior to the use of the island as a bombing range. Also, historical photographs appear to show more intact forested areas on the mesic flats area of the northern portion of the island, which would have provided foraging and roosting habitats on FDM (U.S. Department of the Navy 2013a).

3.10.2.4 Species Considered as Candidates for Endangered Species Act Listing

3.10.2.4.1 Partulid Snails

Four snails in the Partulid family are collectively known as “akaleha” in Chamorro—the humped tree snail (*Partula gibba*), the Guam tree snail (*Partula radiolata*), the fragile tree snail (*Samoana fragilis*), and Langford tree snail (*Partula langfordi*). The shell of the humped tree snail is described as somewhat enlarged resembling a hump in a conical shape with four to five whorls. The shell color is chestnut brown to whitish yellow, or occasionally purple with a white or brown line along the suture between the whorls on the shell (U.S. Fish and Wildlife Service 2008c, d). The humped tree snail was added to candidate listing in 1994 by the USFWS (U.S. Fish and Wildlife Service 2008c). The candidate status was reaffirmed most recently in 2012 by the USFWS (U.S. Fish and Wildlife Service 2012).

The shell of a Guam tree snail is described as somewhat oblong and having a conical shape with five whorls. The shell color is pale straw yellow with darker axial rays and brown lines (U.S. Fish and Wildlife Service 2008d). The Guam tree snail was added to candidate listing in 1994 by the USFWS (U.S. Fish and Wildlife Service 2008d). The candidate status was reaffirmed in 2005 by the USFWS (U.S. Fish and Wildlife Service 2008d).

The fragile tree snail was added to candidate listing in 1994 by the USFWS (U.S. Fish and Wildlife Service 2012). The candidate status was reaffirmed in 2012 (U.S. Fish and Wildlife Service 2012).

Threats to the partulid snails include historical (following World War II) loss of native forest habitat, typhoons, overbrowsing by introduced ungulates, and market collection of tree snails. Predation by the alien rosy carnivore snail (*Euglandina rosea*) and the alien Manokwar flatworm (*Platydemis manokwari*) is a serious threat to the survival of tree snails from the Mariana Islands (U.S. Department of the Navy 2013a; U.S. Fish and Wildlife Service 2012).

Status within the Mariana Islands Training and Testing Study Area

The humped tree snail is the most widely distributed partulid snail in the Mariana Islands (Kerr 2013) and likely occurs within intact limestone forests on Andersen AFB, Naval Base Guam Telecommunications Site at Finegayan, and intact limestone forest areas within the Tinian MLA. The

Guam tree snail has a wide distribution on Guam and also likely occurs in intact forest areas of Andersen AFB and Navy-owned lands. The fragile treesnail is generally restricted to limestone forests of northern Guam (Kerr 2013) and potentially occurs in intact limestone forests of Andersen AFB, Naval Base Guam Telecommunications Site at Finegayan. The Langford tree snail does not occur on DoD-owned or leased lands, and is restricted to Aguiguan. It should be noted that military training activities described in this EIS/OEIS do not occur in these intact limestone forest areas that may be inhabited by Partulid snails.

3.10.2.4.2 Mariana Eight-Spot Butterfly (*Hypolimnas octocula mariannensis*) and Mariana Wandering Butterfly (*Vagrans egistina*)

The Mariana eight-spot butterfly (*Hypolimnas octocula mariannensis*) and the Mariana wandering butterfly (*Vagrans egistina*) are two species in the Nymphalid family of butterflies that are candidates for ESA listing. Both butterflies are known in Chamorro as the "Ababbang" and in Carolinian as "Libwueibogh," and are believed to be endemic to Rota and Guam (Hawley and Castro 2008). Like most nymphalid butterflies, orange and black are the primary colors exhibited by these species. Females are larger than males, appear brighter orange in color than males, and have black bands across the top margins of both pairs of wings. Males are predominantly black with an orange stripe running vertically on each wing. Mariana wandering butterflies do not have an orange stripe, but rather one large orange blot on each wing characterizes this species. The candidate status for these two species was re-affirmed in 2012 (U.S. Fish and Wildlife Service 2012).

Threats to these species include predation by ants, parasitism by small wasps, and extremely low numbers (U.S. Fish and Wildlife Service 2008e, 2012). These butterflies were apparently always uncommon and declined primarily due to browsing of the two host plants by introduced deer and other ungulates. The Mariana eight-spot butterfly is believed to have been extirpated from Saipan, but occurs rarely in Guam's northern forests. During surveys conducted in 1995, areas of Saipan supported healthy populations of the host plants, but no butterflies were observed (Scheiner and Nafus 1996).

Host plants for the Mariana eight-spot larvae include two native herbaceous plants, *Procris pedunculata* and *Elatostema calcareum*. These forest fleshy herbs only grow on karst limestone within limestone forests. *Maytenus thompsoni* is the host plant primarily associated with Mariana wandering butterfly larvae (Hawley and Castro 2008).

Status within the Mariana Islands Training and Testing Study Area

Mariana wandering butterflies have been extirpated from Guam but are still found on Rota. Mariana eight-spot butterflies are still extant on Rota and northern limestone forests of Guam. Two Mariana eight-spot butterflies were observed in 2006 (Lawrence 2006) along a rocky pinnacle karst area toward Pati Point on Andersen AFB. A recent survey conducted by Hawley and Castro (2008) did not find either butterfly on Tinian; however, host plants for these species were identified. Mariana wandering butterflies and Mariana eight-spot butterflies occur in intact limestone forests characterized by rough terrain where no military training activities occur.

3.10.2.4.3 Pacific Sheath-Tailed Bats (*Emballonura semicaudata rotensis*)

The subspecies of the Pacific sheath-tailed bat known to occur throughout the Mariana Islands has not been well studied, and all available information indicates that this insectivorous bat is restricted to Aguiguan (U.S. Fish and Wildlife Service 2009d). Pacific sheath-tailed bats are known to only roost in caves. In 2008, surveys on Aguiguan were completed along with limited acoustical detection sampling on Tinian (using equipment designed to detect echolocating bats). No bats were detected on Tinian in 2008.

Status within the Mariana Islands Training and Testing Study Area

There have been no recent records of Pacific sheath-tailed bats on Tinian (U.S. Fish and Wildlife Service 2009). There are habitats on Tinian that are similar to habitats located on Aguiguan (which is located 5 mi. [8 km]) away from Tinian. Mount Lasso is within the Tinian Military Lease Area (MLA), but the Kastiyu Forest area is on southern Tinian outside of the Tinian MLA.

3.10.3 Environmental Consequences

This section presents the analysis of potential impacts on terrestrial species from implementation of the project alternatives, including the No Action Alternative, Alternative 1, and Alternative 2. Navy training and testing activities are evaluated for their potential impact on terrestrial species in general, by taxonomic groups, and in detail for species listed under the ESA (Section 3.10.2, Affected Environment). For this EIS/OEIS, terrestrial species are evaluated as groups of species characterized by distribution, body type, or behavior relevant to the stressor being evaluated. Vegetation communities and the habitats for species these communities support are evaluated based on location of the training activities, the habitats these training areas support, and the type of stressors that are introduced into these habitats. Activities are evaluated for their potential effect on vegetation communities, wildlife communities, and in general, on each taxonomic grouping, and on the ESA-listed species considered in this analysis (see Section 3.10.1.1.1, Endangered Species Act Listed Species and Designated Critical Habitat). As described in Section 3.10.2 (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 potential stressors were introduced in Section 3.0.5.3 (Identification of Stressors for Analysis). Certain activities on land take place on specific islands and within specific areas of islands. The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to terrestrial species in the study area and analyzed below include the following:

- Acoustic (explosives noise, weapons firing noise, and aircraft noise)
- Physical disturbance and strike (aircraft and aerial targets, military expended materials, ground disturbance, and wildfires)
- Secondary

The specific analysis of the training activities presented in this section considers the relevant components and associated data within the geographic location of the activity (see Tables 2.8-1 and 2.8-2) and the resource. There are no applicable testing activities to terrestrial resources, and therefore they are not analyzed.

3.10.3.1 Acoustic Stressors

This section evaluates the potential for non-impulse and impulse acoustic stressors to impact terrestrial species during training activities on land training areas within the Study Area. There are no testing activities that occur on land that require introducing sound into the environment. These stressors are associated with explosive detonations, aircraft noise, and weapons firing. 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 terrestrial animals from acoustic and explosive stressors include disturbance of foraging, roosting, or breeding; degradation of foraging habitat; and degradation of habitats. Table 3.10-5 lists each substressor, where they occur, and what species potentially are impacted by the activity.

3.10.3.1.1 Impacts from Explosives and Weapons Firing Noise

The potential for animals to be exposed to explosions depends on several factors, including the presence of animals near the detonation, location of the detonation, size of the explosive, and distance from the detonation. Detonations create blast waves and acoustic waves in air and are also transmitted through the ground. Some of the sound could be attenuated by surrounding vegetation. Noise can result from direct munitions impacts (one object striking another), blasts (explosions that result in shock waves), bow shock waves (pressure waves from projectiles flying through the air), and substrate vibrations (combinations of explosion, recoil, or vehicle motion with the ground). Noise may be continuous (i.e., lasting for a long time without interruption) or impulse (i.e., short duration). Continuous impulses (helicopter rotor noise, bursts from rapid-fire weapons) represent an intermediate type of sound and, when repeated rapidly, may resemble continuous noise. These types of sound are distinguished here as they differ in their effects. Continuous sounds can result in hearing damage while impulses typically elicit physiological or behavioral responses.

Continuous or repetitive loud noise appears to cause stress and vascular alteration (including structural damage) in the ear and could be harmful when animals are already under metabolic stress such as starvation. Sound levels over 85 A-weighted decibels (dBA) are considered harmful to inner ear hair cells; 95 dBA is considered unsafe for prolonged periods; and extreme damage occurs as a result of brief exposure to 140 dBA (Hamby 2004). Hearing loss in birds is difficult to characterize because birds, unlike mammals, regenerate inner ear hair cells, even after substantial loss (Corwin and Cotanche 1988; Stone and Rubel 2000). Recovery from metabolic ear stress can often occur after 10 hours (mammals) post loud impulse noise, even before ear structures are fully recovered. Repeated trauma may prolong the course of hearing sensitivity recovery; however, longer-term recovery from hearing loss is generally expected in birds due to cell regeneration. Lifelong hearing loss (threshold shifts) can occur in birds; about half the duration of noise is needed to produce a threshold shift in birds as opposed to mammals.

High-frequency sounds (or ultrasound) diminish very rapidly in air with distance from the source, and terrestrial animals close enough to be adversely affected by the ultrasound produced by military training are likely close enough to be adversely affected by shrapnel, flying rock, or direct strikes. Therefore, ultrasound receives little attention in the terrestrial environment and it should be assumed that if an animal was close enough to experience impacts from ultrasound, the animal would likely be impacted directly by the actual munitions (U.S. Fish and Wildlife Service 2010a). The training activities that have the greatest impact on vegetation and wildlife communities within the impact areas on FDM are those that result in (1) percussive force from the use of explosive munitions, and (2) habitat alteration associated with ground disturbance and wildfires from explosive munitions. The potential for impacts resulting from direct strikes from inert munitions is orders of magnitudes lower than that from explosive munitions, particularly heavyweight explosive bombs (U.S. Department of the Navy 2010). Weapons use (i.e., direct strike) impacts are analyzed in Section 3.10.3.2.2 (Impacts from Military Expended Materials Including Explosive Munitions Fragments).

Infrasound (present in blast and helicopter noise, but not heard by humans) attenuates less in air than audible sound, which means these noises can affect wildlife at longer distances. Birds may use infrasound for communication; however, the extent to which birds are affected by infrasound is speculative. Infrasound can result in damage to the ears, which may affect the species' ability to hear and may also mask biologically meaningful infrasonic communication between individuals.

Table 3.10-5: Acoustic Substressors in Land Training Areas and Terrestrial Resources Potentially Impacted

Acoustic Substressor	Land Training Area	Terrestrial Resource Potentially Impacted
Explosives and Weapons Firing Noise	Andersen AFB (Pati Point CATM Range, Pati Point EOD Range)	Mariana fruit bat, Mariana crow (believed to be extirpated) Non-ESA listed forest birds (e.g., Micronesian starlings)
	Naval Base Guam Main Base (Orote Point Known Distance Range,	None
	Naval Base Guam Munitions Storage Site (emergency detonation site)	Mariana swiftlet Mariana common moorhen Mariana fruit bat
	Naval Base Guam Telecommunications Site (Finegayan Small Arms Range)	None
	FDM	Micronesian megapode Mariana fruit bat
Aircraft Noise	Andersen AFB	Mariana fruit bat, Mariana crow (believed to be extirpated) Non-ESA listed forest birds (e.g., Micronesian starlings)
	Naval Base Guam Main Base	Mariana common moorhen Non-ESA listed terrestrial birds (e.g., yellow bittern)
	Naval Base Guam Munitions Site	Mariana swiftlet Mariana common moorhen Mariana fruit bat
	Tinian MLA	Micronesian megapode Mariana fruit bat Non-ESA listed forest birds (e.g., Tinian monarch)
	Rota	Mariana fruit bat Mariana crow
	FDM	Micronesian megapode Mariana fruit bat

Notes: Andersen AFB = Andersen Air Force Base, CATM = Combat Arms and Maintenance Range, EOD = Explosive Ordnance Detonations, ESA = Endangered Species Act, FDM = Farallon de Medinilla, Tinian MLA = Tinian Military Lease Area

Severe noise, even if the noise is short in duration, can result in tympanum rupture, bone fracture, other damage to the ear, and deterioration of brain cells. These impulse noises can cause physical damage at lower intensity than continuous or rapidly repeating noises due to the ear reflex mechanism. For example, common canaries (*Serinus canaria*) exposed to continuous loud noises experienced changes in hearing thresholds, especially at high frequencies (Larkin et al. 1996). While a study with parakeets (*Melopsittacus undulates*) indicated that a permanent threshold shift (lifelong hearing loss) was experienced at low frequencies only and nearly absent at higher frequencies (Larkin et al. 1996). Many birds appear to tolerate noise that can cause pain in humans, for example: seabirds at airports, wild turkeys (*Meleagris gallopavo*) near a rocket testing plant in Florida, and ospreys (*Pandion haliaetus*) at the Naval Surface Warfare Center, Dahlgren (Larkin et al. 1996).

These varied responses are often attributed to habituation, where after a period of exposure to a stimulus, an animal stops responding to the stimulus. In general, a species can often habituate to human-generated noise when the noise is not followed by an adverse impact. Even when a species appears to be habituated to a noise, the noise may produce a metabolic or stress response (increased heart rate results in increased energy expenditure) although the response may or may not lead to changes in overall energy balance.

In addition to physical damage to the ear, noise also produces other physiological and behavioral responses. The behavioral effects of military-related noise to wildlife have been investigated numerous times with mixed results (VanderWerf 2000); it is difficult, therefore, to generalize predictions about potential responses of Micronesian megapodes to noise based on data from other species. To summarize, noise can produce a variety of physiological impacts and behavioral responses in wildlife. The response to noise not only affects an individual but can affect the overall population. Hearing impairment, both temporary and permanent, can decrease viability or reproductive success, particularly when mate attraction and territory protection depend on calling or singing normally. Hearing impairment can also decrease the ability to detect and warn others of predators. Behavioral responses (startle response, alert or alarm response, and flushing) to noise are often examined as these response actions result in: birds expending excess energy that is not directed toward reproduction; nest exposure increasing the risk of predation, nest cooling or nest heating, which can result in egg and juvenile mortality; or accidently kicking eggs or juveniles out of the nest. Behavioral responses can also include lower breeding densities in suitable habitats that are subject to noise; therefore, suitable habitat may become otherwise unsuitable due to noise. Wildlife response to noise may also be more intense at night, if the species rely more on auditory cues than visual cues at night. Additionally, young animals may be more susceptible to hearing loss from noise exposure than adults; however, an experiment with common canaries did not show a differential response with age (Larkin et al. 1996).

Studies focusing on responses of birds on land to explosive noise show varied reactions ranging from no response to behavioral (e.g., flushing, cessation of foraging) and physiological responses (e.g., increased heart and respiration rates). Red-cockaded woodpeckers (*Picoides borealis*) successfully raised young near an active bombing range in Mississippi; while other birds at other sites did not. Oahu elepaio (*Chasiempis sandwichensis ibidis*) did not respond in statistically significant or biologically meaningful ways to noise generated by training with 155 and 105 millimeter howitzers, 60 and 81 millimeter mortars, hand grenades, and demolition of unexploded ordinance (VanderWerf 2000). Prairie falcons (*Falco mexicanus*) responded to blasts from ongoing civilian construction where the nests sites were not normally exposed to blasting; however, one northern harrier (*Circus cyaneus*) appeared to preferentially hunt near a location where 24-pound (lb.) bombing occurred. Anecdotal observations indicate the burrowing owl (*Athene cuniculariajloridana*) persists at Eglin AFB on a bombing range where a variety of inert ordnance (rockets, missiles, and bombs including a 21,700 lb. massive ordnance air blast bomb) has been used over the last 24 years (U.S. Fish and Wildlife Service 2010a).

Behavioral responses (startle response, alert or alarm response, and flushing) to noise are often examined as these response actions result in birds expending excess energy not directed toward reproduction; nest exposure increasing the risk of predation, nest cooling or nest heating, which can result in egg and juvenile mortality; or accidently kicking eggs or juveniles out of the nest. Behavioral responses can also include lower breeding densities in suitable habitats that are subject to noise; therefore, suitable habitat may become otherwise unsuitable due to noise.

3.10.3.1.1.1 No Action Alternative

Training Activities

As shown in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives), land-based detonations occur primarily on FDM as part of strike warfare and firing exercises; however land detonations for training associated with unexploded ordnance discovery/disposal training and improvised explosive device training occur at Andersen AFB on Guam (Northwest Field and Pati Point Explosive Ordnance Disposal Range). Weapons firing activities under the No Action Alternative occur at ranges on Guam, and during fixed-wing air to ground gunnery exercises and missile exercises, as well as during helicopter-based fire support for amphibious warfare training.

Land-based detonations at the Pati Point Explosive Ordnance Disposal Range were the subject of earlier consultations between Andersen AFB and the USFWS (U.S. Department of the Navy 2009; U.S. Fish and Wildlife Service 2010a). The Pacific Islands Fish and Wildlife Office concluded that activities at the Pati Point Explosive Ordnance Disposal Range would not adversely affect ESA-listed species. Because of the current status of the Mariana crow on Guam, it is unlikely that any remnant crows would be near explosive training at the range. Other species thought to be absent from habitats surrounding the Pati Point Range (Guam rail, Guam Micronesian kingfisher, Mariana common moorhen) will not be impacted. Transiting Mariana fruit bats, however, may experience temporary behavioral changes associated with blasts at the range. The effects of these exposures are likely to be temporary and infrequent. Native birds, such as the Micronesian starling, may exhibit behavioral responses to explosive noise, particularly at Pati Point ranges. These infrequent detonations are not expected to induce adverse population effects. It should be noted that Micronesian starling numbers are increasing in developed areas of Andersen AFB. These detonation activities occur on hardened surfaces and do not present a wildfire risk or impacts to vegetation communities.

Explosive noise from strike warfare training at FDM impacts wildlife assemblages (primarily avifauna), and ESA-listed species (Lusk et al. 2000). Section 3.6 (Marine Birds) discusses the impacts to FDM's bird populations resulting from explosive noise. Section 3.10.3.2.4 (Impacts from Wildfires) and Section 3.10.3.2.2 (Impacts from Munitions Strike) discuss the potential impacts that explosions have on vegetation communities through a history of intense bombardment. Table 3.0-22 lists representative ordnance use on FDM under the No Action Alternative.

Mariana fruit bats on FDM may be transient bats (bats from other islands). The limited forest structure and composition currently found on FDM may support a small number of year-round residents. Natural resource experts expressed concern that volcanic eruptions could displace fruit bats to other islands (e.g., from Anatahan to FDM), thereby exposing an increased number of bats to potential impacts of military training on FDM (U.S. Fish and Wildlife Service 2006a, 2010a). It should be noted that after the Anatahan eruption began in 2003, the number of bat observations on other islands did not increase. However, the genetic variation demonstrated by fruit bats found in the far northern islands of the Mariana Archipelago and those bats found in the southern islands suggests that interisland movements do occur and are sufficient for northern bats and southern bats to not be classified as separate species or sub-species (Brown et al. 2011).

The Micronesian megapode would be exposed to noise and pressure waves from explosions on FDM from strike warfare and firing exercises. Response of the Micronesian megapode to explosive noise has not been evaluated under scientific investigation (U.S. Fish and Wildlife Service 2010a); however, Micronesian megapodes are vocal and presumably find mates and defend territories by duetting (U.S. Fish and Wildlife Service 1998). Therefore, explosive noise and pressure waves generated from explosions would impact the Micronesian megapode if it physically damages the ears such that an individual cannot hear and locate a mate; produces abnormal calls (hearing impaired learning) and cannot attract a mate; or is unable to defend a territory.

Other concerns from noise impacts to avian species are related to nesting and impacts to eggs or chicks (i.e., mortality through kicking eggs or young out of the nest during flushing, exposing young to temperature changes, failing to feed and care for young during nest flushing, exposing eggs and young to increased predation). Micronesian megapodes generally bury their eggs in mounds in which temperature is controlled by sources other than the bird (U.S. Fish and Wildlife Service 2010a). Chicks are precocial, able to fly upon emergence from the egg and not requiring parental care (U.S. Fish and Wildlife Service 1998). Therefore, behavioral responses typical to other avian species are not likely to result in adverse impacts to eggs, chicks, or juveniles of Micronesian megapodes.

Besides the Micronesian megapode, terrestrial bird species do not likely breed on FDM. There are a few terrestrial bird species that visit the island, such as the fork-tailed swiftlet, Eurasian tree-sparrow, and cattle egret. While visiting FDM, or using FDM as stopover habitat along migration routes, these birds would be exposed to noise and pressure waves from explosions on FDM from strike warfare and firing exercises. Some birds may be killed or injured during these activities, or expend energy stores needed for migration to avoid perturbations generated by explosions.

There are a number of protective measures for FDM that minimize potential adverse impacts associated with explosives to Micronesian megapodes and habitats used by megapodes and other terrestrial animals. The protective measures were included in the 2010 USFWS Biological Opinion that included the Navy's use of FDM (U.S. Fish and Wildlife Service 2010a). The measures include maintaining prohibitions on targeting the northern end of the island (which continues to support higher stature trees), placing of targets within impact areas, and maintaining prohibitions on the use of cluster bombs, bombs greater than 2,000 lb. net explosive weight (NEW), fuel-air explosives, and incendiary devices.

Pursuant to the ESA, sound generated from explosions and weapons firing on land during training activities under the No Action Alternative will not affect the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam rail, Guam Micronesian kingfisher, Mariana common moorhen, Mariana crow, Mariana swiftlet, and nightingale reed-warbler. Explosions on FDM may affect, but not likely adversely affect, the Mariana fruit bat. Explosions on FDM may affect, and are likely to adversely affect, the Micronesian megapode and Mariana fruit bat.*

Critical Habitats on Guam or Rota will not be affected by explosive noise or weapons firing noise.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), explosions and weapons firing on land during training activities under the No Action Alternative will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

There are no testing activities that occur on land. Therefore, there are no potential impacts on terrestrial species or habitats.

3.10.3.1.1.2 Alternative 1

Training Activities

The number of detonations as part of explosive ordnance disposal and improvised explosive training will not change in Alternative 1, relative to the No Action Alternative. Therefore, the conclusion of the impacts on wildlife communities, ESA-listed species, and other terrestrial bird species not listed under the ESA on Guam associated with explosive noise is the same.

Appendix A (Activities Descriptions) lists the training and testing activities that use ordnance on FDM. The number of ordnance use on FDM is summarized for Alternative 1 in Table 3.0-22. At FDM, the use of explosive munitions in bombs would increase by 98 percent, and grenades and mortars would increase from 100 to 600 grenades and mortars launched at the island. Large caliber projectiles with explosive rounds (explosives class E3 [0.6 to 2.0 lb.]) would increase by 20 percent. The largest increases proposed under Alternative 1 are with small caliber rounds, from 2,900 under the No Action Alternative to 42,000 small caliber non-explosive rounds under Alternative 1. The proposed changes in ordnance use reflect the increased importance of FDM as a training area for close air support type training activities.

As stated previously, the most important stressors to wildlife communities, including Micronesian megapodes and Mariana fruit bats on FDM are (1) percussive force from the use of explosive munitions, and (2) habitat alteration associated with ground disturbance and wildfires from explosive munitions. It should be noted that direct strike from inert munitions is far less likely to impact a megapode or bat relative to the potential for blast effects associated with explosive munitions, especially heavy weight munitions. Direct strike (by projectiles and explosive munition fragments) is analyzed in Section 3.10.3.2 (Physical Stressors). Although exposures to Micronesian megapodes, and potentially Mariana fruit bats, 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 all three alternatives. For the same reasons provided in Section 3.10.3.1.2.1 (No Action Alternative), explosive noise may impact the Micronesian megapode if it physically damages the ears such that: an individual cannot hear and locate a mate; produces abnormal calls (hearing impaired learning) and cannot attract a mate; or is unable to defend a territory. As discussed under the No Action Alternative, there are a few terrestrial bird species that visit the island, such as the fork-tailed swiftlet, Eurasian tree-sparrow, and cattle egret. While visiting FDM, or using FDM as stopover habitat along migration routes, these birds would be exposed to noise and pressure waves from explosions on FDM from strike warfare and firing exercises. These exposures would increase under Alternative 1. Some birds may be killed or injured during these activities, or expend energy stores needed for migration to avoid perturbations generated by explosions.

The Navy will continue protective measures to minimize the impacts to terrestrial species and habitats, pursuant with the USFWS Biological Opinion for Mariana Islands Range Complex (MIRC) training activities (U.S. Fish and Wildlife Service 2010a).

Pursuant to the ESA, sound generated from explosions and weapons firing on land during training activities under Alternative 1 will not affect the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam rail, Guam Micronesian kingfisher, Mariana common moorhen, Mariana crow, Mariana swiftlet, and nightingale reed-warbler. Explosions on FDM may affect, and are likely to adversely affect, the Micronesian megapode and the Mariana fruit bat.*

Critical Habitats on Guam or Rota will not be affected by explosive noise or weapons firing noise.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), explosions and weapons firing on land during training activities under Alternative 1 will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

Under Alternative 1, there are no testing activities that would involve explosions on land. Therefore, there are no potential impacts on terrestrial species or habitats.

3.10.3.1.1.3 Alternative 2

Training Activities

The number of detonations as part of explosive ordnance disposal and improvised explosive training will not change in Alternative 2, relative to the No Action Alternative. Therefore, the conclusion of the impacts on wildlife communities, ESA-listed species, and other terrestrial bird species not listed under the ESA on Guam associated with explosive noise is the same.

On FDM, the explosive munitions use proposed under Alternative 2 differs only in the 2,000 lb. bomb category. Under Alternative 2, an additional 579 bombs in this category would be dropped relative to Alternative 1.

Although exposures to Micronesian megapodes, and potentially Mariana fruit bats, are expected to increase under Alternative 2 compared to the No Action Alternative, the expected impacts on any individual bird would remain the same for all three alternatives. Exposures to Micronesian megapodes, Mariana fruit bats, and the few terrestrial bird species that visit FDM would increase under Alternative 2 relative to the No Action Alternative. Some birds may be killed or injured during these activities, or expend energy stores needed for migration to avoid perturbations generated by explosions.

The Navy will continue protective measures to minimize the impacts to terrestrial species and habitats, pursuant with the USFWS Biological Opinion for MIRC training activities (U.S. Fish and Wildlife Service 2010a).

Pursuant to the ESA, sound generated from explosions and weapons firing on land during training activities under Alternative 2 will not affect the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam rail, Guam Micronesian kingfisher, Mariana common moorhen, Mariana crow, Mariana swiftlet, and nightingale reed-warbler. Explosions on FDM may affect, and are likely to adversely affect, the Micronesian megapode and Mariana fruit bat.*

Critical Habitats on Guam or Rota will not be affected by explosive noise or weapons firing noise.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), explosions and weapons firing on land during training activities under Alternative 2 will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

Under Alternative 2, there are no testing activities that would involve explosions on land. Therefore, there are no potential impacts on terrestrial species or habitats.

3.10.3.1.2 Impacts from Aircraft Noise

3.10.3.1.2.1 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. Most helicopter training would occur adjacent to areas at Naval Base Guam Apra Harbor, Andersen AFB, Tinian landing beaches, and some transits to FDM and to training areas and drop zones at sea. Some training involving combat search and rescue training activities may occur at Rota International Airport.

Andersen AFB completed an aircraft noise and wildlife response study at Northwest Field, Munitions Storage Area, and Pati Point to monitor the effects of noise events associated with aircraft operations to the Mariana fruit bat and Mariana crow (SWCA Environmental Consultants 2009). The study monitored various behaviors of individual bats during periods of no aircraft noise and periods of take-offs and landings, and flushing behaviors associated with the Pati Point Mariana fruit bat colony as a whole. No flushing of the entire Mariana fruit bat colony was observed during any aircraft overflight activity (SWCA Environmental Consultants 2009). Flushing episodes associated with overflights were infrequent at less than 5 percent (on 228 occasions) but increased to 6 percent for overflights above 100 dB (in the SWCA study, noise was measured in dBC, or decibels referenced to the carrier). In all flushing events, noise levels remained above 75 dBC for between 31 and 87 seconds. The majority of flush events involved less than three individuals at one time (SWCA Environmental Consultants 2009). On one occasion, 14 fruit bats simultaneously flew from their colony roost sites and circled the main colony and surrounding cliff line. Noise from the aircraft peaked at 121.1 dBC and lasted almost 35 seconds (above 75 dBC), causing between 38 and 50 percent of the fruit bats to flush. Flushed individuals were in flight for a relatively short period, generally resettling between 7 and 10 minutes after first flight.

Anecdotal observations of the last two remaining Mariana crows on Andersen AFB (both males) were made during aircraft overflights. On three occasions fighter aircraft passed close to the crows. On all occasions, fighter jets departed from either the north or south runway of Andersen Main and flew around the south side of the Munitions Storage Area. Although both crows were alert and aware of the noise, neither departed the nest site. No direct overflights or noise level data were recorded during these occasions (SWCA Environmental Consultants 2009). Micronesian starlings nest and forage in and adjacent to the developed portions of Andersen AFB, and have likely habituated to aircraft noise. Their reported increased on Guam suggest that the population of this species is not adversely affected by aircraft noise (U.S. Department of the Navy 2013a).

Fena Reservoir is a 203 ac. (82 ha) lake within the Naval Base Guam Munitions Site and supports a Mariana moorhen population (Guam Division of Aquatic and Wildlife Resources 2006). Helicopter-based fire bucket training occurs near the Fena Spillway on a regular basis, along with frequent overflights of HC-25s. In April 2009, two moorhens were observed near the spillway foraging in nearby aquatic vegetation, and during the wet season of 2008, six moorhens were observed in the shallower portions of the reservoir (U.S. Fish and Wildlife Service 2009b). Any moorhens that are at Fena Reservoir at the time of helicopter-based training will be exposed to noise and visual disturbance. Noise from helicopter overflights most likely adversely affect moorhens by masking predator approaches and mating calls; however, other limiting factors seem to be more important, such as the decline of some aquatic emergent vegetation species since noise events for helicopter operations are short term. No noise studies have been conducted to measure responses of Mariana common moorhens to military noise (such as helicopter overflights). To minimize effects of this training activity, Navy natural resource specialists with specific Mariana common moorhen experience monitor any moorhens for behavioral responses during the first three fire bucket training exercises. In addition, the Navy maintains altitude restrictions over Fena Reservoir for helicopters and fixed wing aircraft outside the helicopter fire bucket training area. Continued use of the area may suggest an ability for the moorhen to acclimate to periodic increases in noise.

Other than the Mariana common moorhen, the only native resident terrestrial bird known to occur at Naval Base Guam Munitions Site is the yellow bittern. Population trends are not available for this species at this installation (U.S. Department of the Navy 2013a).

On Rota, aircraft noise would be generated by helicopters during combat search and rescue training activities. Typically, the Navy uses H-60 helicopters to practice day or night rescues of personnel in a simulated hostile area with the expectation of combat resistance. Crews typically include Naval special warfare personnel or combat trained personnel with rescue swimmer and medical qualifications. This activity is mostly restricted to the Rota International Airport; however, other locations may be used in coordination with local authorities (e.g., Rota’s mayor office). Helicopters may also transit out to sea for rescue swimmer training.

The Rota International Airport is located on the east side of Rota (see Figure 3.10-2) and is near the critical habitat designation for the Mariana crow and foraging areas for the Mariana fruit bat. The Sabana Plateau is on the western portion of the island (the location of Rota bridled white-eyes and critical habitat, Mariana fruit bat roost locations and critical habitat, and other important habitats associated with the Sabana Plateau). Low altitude overflights do not occur in critical habitat designations or designated conservation areas. Because the combat search and rescue training occurs near occupied habitat for the Mariana crow, aircraft noise may affect the Mariana crow. Combat search and rescue training, however, occurs infrequently on Rota, with the majority of these training activities scheduled to occur on Guam. Adverse effects to the Mariana crow are not anticipated because critical habitat areas are avoided and this training activity occurs infrequently.

Mariana fruit bats are generally more active at night (a primary time for foraging when bats would fan out over Rota from roost locations in the limestone forests of the Sabana Plateau). Because suitable foraging habitat is adjacent to the Rota International Airport, helicopter noise may affect the Mariana fruit bat. Adverse effects associated with this training activity are anticipated to be insignificant because the infrequent use of the Rota International Airport and the even more infrequent low light exercises associated with this training activity will not likely adversely affect the Mariana fruit bat.

Pursuant to the ESA, noise generated from aircraft overflights over land during training activities under the No Action Alternative will not affect the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam rail, Guam Micronesian kingfisher or the nightingale reed-warbler. Noise generated from aircraft overflights may affect, but not likely adversely affect, the Mariana common moorhen, Mariana crow, Mariana fruit bat, Mariana swiftlet, and the Micronesian megapode.*

Critical Habitats on Guam or Rota will not be affected by aircraft noise.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), noise generated from aircraft overflights over land under the No Action Alternative will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

There are no testing activities that occur on land. Therefore, there are no potential impacts on terrestrial species or habitats.

3.10.3.1.2.2 Alternative 1 and Alternative 2

Training activities under Alternative 1 and Alternative 2 would increase fixed- and rotary-wing aircraft overflights throughout the Study Area. Most helicopter training would occur adjacent to areas at Naval Base Guam Apra Harbor, Andersen AFB, Tinian landing beaches, and some transits to FDM and to training areas and drop zones at sea. Most increases would occur at FDM with five-fold increase in the number of sorties associated with bombing exercises during strike warfare training. Most of these flights, however, would be at high altitudes to reduce intensity of the sound.

Combat search and rescue training on Rota under Alternative 1 and Alternative 2 will not change relative to the No Action Alternative. Therefore, aircraft overflights associated with training activities may affect, but not likely adversely affect, Mariana fruit bats and Mariana crows on Rota. Activities at Fena Reservoir (within Naval Base Guam Munitions Site) would not change under Alternative 1 or Alternative 2, and the number of helicopter training supporting insertion/extraction and urban warfare type training activities would not change above the No Action Alternative. Therefore, under Alternative 1 and Alternative 2, increases in activities that generate aircraft noise may affect, but not likely adversely affect, Micronesian megapodes at FDM.

As with the No Action Alternative and Alternative 1, aircraft noise would not adversely impact bird populations for species not listed under the ESA, but protected under the MBTA.

Pursuant to the ESA, sound generated from aircraft overflights over land during training activities under Alternative 1 or Alternative 2 will not affect the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam rail, Guam Micronesian kingfisher or the nightingale reed-warbler. Sound generated from aircraft overflights may affect, but not likely adversely affect, the Mariana common moorhen, Mariana crow, Mariana fruit bat, Mariana swiftlet, and the Micronesian megapode.*

Critical Habitats on Guam or Rota will not be affected by aircraft noise.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), noise generated from aircraft overflights over land under Alternative 1 or Alternative 2 will not result in significant adverse effect on terrestrial bird populations.

Testing Activities

There are no testing activities that occur on land. Therefore, there are no potential impacts on terrestrial species or habitats.

3.10.3.2 Physical Stressors

This section describes the potential impacts to wildlife and ESA-listed terrestrial species by aircraft and aerial targets, military expended material strike including explosive munitions fragments, ground disturbance, and wildfires at FDM. Table 2.8-1 in Chapter 2 (Description of Proposed Action and Alternatives) lists activity types, number of activities, and locations where these activities occur that involve physical stressors. Aircraft include fixed-wing and rotary-wing aircraft; munitions include small, medium, and large caliber non-explosive and explosive rounds, as well as rockets, missiles, and bombs; ground disturbance includes trampling (foot traffic) and bivouac training; and wildfires result from ignition of vegetation from munitions use. Aerial targets are used at high altitudes and away from land areas; therefore, the potential for strike of terrestrial animals is discounted and not analyzed further in this EIS/OEIS. These activities vary in location and potentially impact different species based on the species distribution, status within the training area, habitats within the training area, and the type of activity. Table 3.10-6 lists each substressor, where they occur, and what species potentially are impacted by the activity. Physical disturbance and strike of seabird and shorebird species (including ESA-listed) seabird species are addressed in Section 3.6.3.3 (Physical Stressors).

3.10.3.2.1 Impacts from Aircraft and Aerial Target Strike

Wildlife aircraft strikes are a serious concern for the Navy and Air Force because these incidents can harm 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.

Although bird strikes can occur anywhere aircraft are operated, Navy and Air Force data indicate they occur more often over land (Air Force Safety Center 2007; Navy Safety Center 2009; U.S. Department of Defense 2012). Potential for wildlife strike is greatest in foraging or resting areas, in migration corridors, and at low altitudes. For example, birds can be attracted to airports because they often provide foraging and nesting resources (Federal Aviation Administration 2003; U.S. Department of Defense 2012). Typical flight altitudes during air-to-surface bombing exercises are from 500 to 5,000 ft. (152.4 to 1,524 m) above ground level. Most fixed-wing aircraft flight hours (greater than 90 percent) occur at distances greater than 12 nm offshore. Approximately 95 percent of bird flight during migration occurs below 10,000 ft. (3,048 m), with the majority below 3,000 ft. (914.4 m) (Air Force Safety Center 2007; Navy Safety Center 2009; U.S. Department of Defense 2012). 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. (152.4 m). Air Force data support this statistic, showing that approximately 70 percent of collisions at U.S. Air Force-administered airfields occur below 500 ft. (152.4 m) (U.S. Department of Defense 2012). Collisions, however, have been recorded at elevations as high as 12,139 ft. (3,700 m) (Buchannan 2011). The Micronesian megapode and Mariana fruit bat are not expected to occur above 500 ft. (152.4 m) above ground level; therefore, these species would not likely be impacted by aircraft overflights and are not carried forward for analysis at FDM.

Part of aviation safety during training and testing activities is the implementation of the Bird/Animal Aircraft Strike Hazard program. The Bird/Animal Aircraft Strike Hazard program manages risk by addressing specific aviation safety hazards associated with wildlife near airfields through coordination among all the entities supporting the aviation mission (U.S. Department of Defense 2012). The Bird/Animal Aircraft Strike Hazard program consists of, among other things, identifying the bird/animal species involved and the location of the strikes to understand why the species is attracted to a particular area of the airfield or training route. By knowing the species involved, managers can understand the habitat and food habits of the species. A Wildlife Hazard Assessment identifies the areas of the airfield that are attractive to the wildlife and provides recommendations to remove or modify the attractive feature. Recommendations may include removal of unused airfield equipment to eliminate perch sites, placement of anti-perching devices, wiring of streams and ponds, removal of brush/trees, use of pyrotechnics, and modification of the grass mowing program (U.S. Department of Defense 2012). Air Force Instruction 91-202 requires Andersen AFB to implement a Bird/Animal Aircraft Strike Hazard Plan. The Andersen AFB Bird/Animal Aircraft Strike Hazard plan provides guidance for reducing the incidents of bird strikes in and around areas where flight training is being conducted. At Andersen AFB, the only regular location of fixed-wing take offs and landings, a sound cannon is deployed on the runway to discourage birds from accumulating on or near the runway. The plan is reviewed annually and updated as needed. Bird/Animal Aircraft Strike Hazard plans are not required around Northwest Field and Orote Air Field on Guam, and North Field on Tinian. Several common bird species that might be present and pose a hazard to military aircraft include shorebirds, black drongos, Micronesian starlings, Eurasian tree sparrows, island collared doves, and Mariana fruit bats (U.S. Department of the Navy 2013a). Mariana fruit bats have been struck by aircraft at Andersen AFB; these animals are primarily active at night and are relatively less maneuverable than birds. Helicopter flights would occur closer to the shoreline where sheltering, roosting, and foraging of birds occur. Helicopters can hover and fly low and are used to tow electromagnetic devices as well as for other military activities at sea. This combination would increase the chances of a helicopter strike of a bird. Additional details on typical altitudes and characteristics of aircraft used in the Study Area are provided in Section 3.0.5.3 (Identification of Stressors for Analysis).

3.10.3.2.1.1 No Action Alternative

<u>Training Activities</u>

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 and Air Force airfields, installations, and ranges are used more heavily by Navy and Air Force aircraft 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 (Identification of Stressors for Analysis).

Table 3.10-6: Physical Disturbance and Strike Substressors in Land Training Areas and Terrestrial Resources Potentially Impacted

Physical Disturbance and Strike Substressor	Land Training Area	Terrestrial Resource Potentially Impacted
Aircraft and aerial target strike	Andersen AFB	Mariana fruit bat, Mariana crow (believed to be extirpated) Non-ESA listed forest birds (e.g., Micronesian starlings)
	Fena Reservoir	Mariana fruit bat Mariana common moorhen Mariana swiftlet Non-ESA listed forest birds
	Rota (Rota International Airport)	Mariana fruit bat Mariana crow Non-ESA listed forest birds
	Tinian MLA	Micronesian megapode Non-ESA listed forest birds (e.g., Tinian monarch)
	FDM	Micronesian megapode Mariana fruit bat Non-ESA listed forest birds,
Military expended materials	FDM	Micronesian megapode Mariana fruit bat Non-ESA listed forest birds
Ground disturbance (Pedestrian and vehicular traffic)	Naval Munitions Storage (Northern Land Navigation Area and Southern Land Navigation Area)	Mariana swiftlet Mariana common moorhen Mariana fruit bat Vegetation communities Non-ESA listed forest birds (e.g., yellow bittern)
	Tinian MLA	Micronesian megapode Vegetation communities Non-ESA listed forest birds (e.g., Tinian monarch)
	Marpi Maneuver Area (Saipan)	Nightingale reed-warbler Mariana fruit bat Micronesian megapode Vegetation communities Non-ESA listed forest birds (e.g., rufous fantail)
	FDM	Micronesian megapode Mariana fruit bat Vegetation communities Non-ESA listed forest birds,
Wildfires	FDM	Micronesian megapode Mariana fruit bat Non-ESA listed forest birds, Vegetation communities

Notes: Andersen AFB = Andersen Air Force Base, ESA = Endangered Species Act, FDM = Farallon de Medinilla, Tinian MLA = Tinian Military Lease Area

Exposures to birds and fruit bats to potential aircraft strikes would be relatively brief as an aircraft quickly passes. Birds actively avoid interaction with aircraft; however, disturbances or strike of various bird species may occur from aircraft on a site-specific basis. As a standard operating procedure, aircraft avoid large flocks of birds to minimize the safety risk to personnel from 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. Mariana fruit bats would not likely be impacted by aircraft strike because of (1) the relatively low height this species typically transits between roost sites and foraging areas, and (2) the likelihood that Mariana fruit bats would avoid loud sound generated by aircraft by remaining in the forest canopy or moving away from the sound source. Mariana fruit bats that fly at altitudes above the cliffline at Andersen AFB would be within flight paths of planes on approach and take-off. However, the potential for strike is low (because of nocturnal activity of bats and the noise generated by approaching aircraft).

With the exception of the Mariana crow (which is likely extirpated), the only other native terrestrial birds species that occur at Andersen AFB are the Micronesian starling and the yellow bittern. As stated previously, this species is increasing in numbers at Andersen AFB. In the unlikely event of an aircraft strike, the death or injury of a low number of birds would not adversely impact the Micronesian starling bird population.

As described in Section 3.10.3.1.2 (Impacts from Aircraft Noise), low level helicopter training occurs at Fena Reservoir as part of helicopter bucket training. This activity occurs where Mariana common moorhens may be located; however, the noise of the activity would likely cause Mariana common moorhens to move away from the sound source. Therefore, although Mariana common moorhens would be likely disturbed by noise of helicopters, direct strike of a moorhen is unlikely. Based on the infrequent use of the Fena Reservoir area by Mariana fruit bats (as described previously), the primarily nocturnal activity of bats on Guam, and the lack of night-time helicopter flights, Mariana fruit bats would unlikely be struck by helicopter trainings at Naval Base Guam Munitions Site. Mariana swiftlets leave caves located on the facility primarily at dusk and return at night. Some swiftlets, however, may leave caves during nesting periods to incubate eggs and to feed hatchlings. Most of the swiftlet activity outside of caves does not occur during helicopter flight times. Further, flight restrictions in place because of explosive safety arcs limit the location of low-level helicopter flights, which reduces the potential for low-level interactions with Mariana fruit bats, Mariana swiftlets, or birds otherwise protected by the MBTA.

At the Rota International Airport, combat search and rescue training occurs in areas adjacent to habitats used by Mariana crows and Mariana fruit bats. This training activity, however, is generally confined to the airfield where these species are unlikely to occur. Trainings may also occur in open areas in coordination with local authorities. The likelihood for aircraft strike during combat search and rescue training should be considered extremely low because of the infrequent occurrence of the training activity and the locations of where these training activities are actually scheduled. There is an elevated risk for night exercises for the Mariana fruit bats because fruit bats, particularly at night, may disperse from intact limestone forest areas in search of foraging trees across the island. These night dispersions may co-occur with combat search and rescue low-level flights in open areas. Because the training activities that occur at night are infrequent, and the training activities are generally associated with open areas, the likelihood of injury or mortality of a Mariana fruit bat is discountable. Therefore, combat search and rescue training may affect, but not likely adversely affect, the Mariana fruit bat.

Pursuant to the ESA, aircraft and aerial target strikes during training activities under the No Action Alternative will not affect the Serianthes tree, Osmoxylon mariannense, Nesogenes rotensis, Rota bridled white-eye, Guam rail, Guam Micronesian kingfisher, nightingale reed-warbler, Mariana common moorhen, Mariana crow, or Mariana swiftlet. Aircraft and aerial target strikes during training activities under the No Action Alternative may affect, but not likely adversely affect the Mariana fruit bat or the Micronesian megapode.

Critical Habitats on Guam or Rota will not be affected by potential aircraft and aerial target strikes.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), aircraft and aerial target strikes under the No Action Alternative will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

There are no testing activities that occur on land. Therefore, there are no potential impacts on terrestrial species or habitats.

3.10.3.2.1.2 Alternative 1 and Alternative 2

Training Activities

Training activities under Alternative 1 and Alternative 2 would increase fixed- and rotary-wing aircraft overflights throughout the Study Area. No new land training areas are proposed for overflights under Alternative 1 or Alternative 2. As with the No Action Alternative, most helicopter training would occur adjacent to areas at Naval Base Guam Apra Harbor, Andersen AFB, Tinian landing beaches, and some transits to FDM and to training areas and drop zones at sea. Most increases would occur at FDM with a five-fold increase in the number of sorties associated with bombing exercises during strike warfare training. Most of these flights, however, would be at high altitudes where wildlife species, including ESA-listed species, would not co-occur with aircraft.

Pursuant to the ESA, aircraft and aerial target strikes during training activities under Alternative 1 and Alternative 2 will not affect the Serianthes tree, Osmoxylon mariannense, Nesogenes rotensis, Rota bridled white-eye, Guam rail, Guam Micronesian kingfisher, nightingale reed-warbler, Mariana common moorhen, Mariana crow, or Mariana swiftlet. Aircraft and aerial target strikes during training activities under Alternative 1 and Alternative 2 may affect, but not likely adversely affect, the Mariana fruit bat or the Micronesian megapode.

Critical Habitats on Guam or Rota will not be affected by potential aircraft and aerial target strikes.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), aircraft and aerial target strikes under Alternative 1 and Alternative 2 will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

Under Alternative 1 and Alternative 2, there are no testing activities that would involve aircraft overflights over land. Therefore, potential aircraft strikes of terrestrial species or habitats during testing activities would not occur.

3.10.3.2.2 Impacts from Military Expended Materials Including Explosive Munitions Fragments

This section analyzes the strike potential to birds of the following categories of military expended materials: (1) non-explosive practice munitions, and (2) fragments from high-explosive munitions. Expended materials other than ordnance, such as sonobuoys, vessel hulks, and expendable targets, are not used in terrestrial habitats, and are therefore not included in the analysis. Munitions are only dropped on FDM; therefore, only activities that expend munitions that occur at FDM are included for analysis. Live-fire training occurs on contained ranges, breacher houses, and MOUT-type training facilities within the Study Area's land training areas; however, these areas contain berms or bullet traps that would prevent small arms munitions from entering into terrestrial habitats. At-sea ranges, such as small arms training for boarding exercises, occur sufficiently far from land and do not warrant analysis for impacts to terrestrial species and habitats.

At FDM, there is potential for munitions to strike the Micronesian megapode. As stated in Section 3.10.2.3.8 (Micronesian Megapode/Sasangat [*Megapodius laperouse laperouse*]), FDM supports a number of Micronesian megapodes and, therefore, concentrations of birds at different times of year are likely to co-occur with training exercises. Megapodes on FDM have persisted on FDM through various phases of intense bombardment of the island from the 1970s to the present. The history of the military use of FDM is summarized in Section 3.10.2.1.5 (Farallon de Medinilla), and a brief summary of human exploitation prior to military use of the island is provided in Section 3.6.2.5 (Rookery Locations and Breeding Activities within the Mariana Islands Training and Testing Study Area). On FDM, the range area where ordnance is restricted to inert munitions, vegetation is recovering in vertical structure and surface cover, relative to range areas where high explosive ordnance is permitted (U.S. Department of the Navy 2008c, 2012). Micronesian megapodes have been observed —within this area, although in apparent lower densities relative to areas north of the "special use area" where no live-fire training occurs (U.S. Department of the Navy 2008c).

As stated previously, the potential for injury to Micronesian megapodes on FDM, and potentially Mariana fruit bats that may occur on the island, associated with direct strike from inert munitions is considerably lower than the potential for blast effects associated with explosive munitions. This is especially true with heavy weight munitions. By way of example, a single Mk 84 (2,000 lb. explosive bomb) has a hazardous fragment distance of over 1,000 ft. (304.8 m) (U.S. Department of Defense 2004). This will result in an area, within which animals could be injured or killed and habitat disturbed, of approximately 60 ac. (24 ha). For a single Mk 48 (25 lb. non explosive practice bomb), an animal would need to be directly struck, or in very close proximity to the area of impact. Allowing for a conservative estimate of an injury zone to be defined as 3 ft. from the impact, the resultant area would be just over 9 square feet ($ft.^2$) ($0.8\ m^2$). For a 20 millimeter projectile, the zone of potential injury would be a smaller area, conservatively estimated at 0.5 $ft.^2$ ($0.05\ m^2$). Hundreds of thousands of 20 millimeter projectiles would need to be expended at a single time and evenly distributed over a given area to equal the impact footprint of a single Mk 84 heavyweight bomb.

3.10.3.2.2.1 No Action Alternative

<u>**Training Activities**</u>

Under the No Action Alternative, use of inert and live-fire target areas on FDM is expected to impact Micronesian megapodes. Most of these impacts are associated with the use of explosive munitions described above in Section 3.10.3.1.1 (Impacts from Explosions and Weapons Firing). Approximately five pairs of Micronesian megapodes (extrapolated from survey data) may be using the area around the inert and live-fire target areas on FDM and are at risk for a direct strike from ordnance (U.S. Department of the Navy 2009; U.S. Fish and Wildlife Service 2010a). Mariana fruit bats are not likely to be struck by munitions because bats are expected to only occur in relatively intact closed-canopy forests that persist north of the "No Fire Line," and also the infrequent use of FDM as foraging habitats (U.S. Fish and Wildlife Service 2010a). The possibility, however remote, is not discountable, and would result in injury or mortality of individual transient fruit bats.

The Navy's range manual for the use of FDM contains training restrictions that reduce the potential for direct strike by munitions. For instance, reducing the potential for direct strike from munitions of megapodes and transiting fruit bats is achieved by implementing targeting and weapons restrictions for the northern portion of FDM. Use constraints include targeting restrictions on missile, firing, gunnery exercises, and other amphibious assault exercises. No weapons system is targeted north of the designated "No Fire Line." Bombing exercise restrictions include: (1) targeting three impact areas (only two are for live ordnance) located on the interior plateau of the island and the southern peninsula (the impact areas total approximately 34 ac. (13.8 ha), which accounts for 20 percent of the island's area); (2) prohibiting cluster bombs and fuel-air explosives or incendiary devices; and (3) placement of targets away from the most sensitive areas, such as seabird nests, and potential roosting sites for transient Mariana fruit bats.

Besides the Micronesian megapode, no terrestrial bird species likely breeds on FDM. There are a few terrestrial bird species that visit the island, such as the fork-tailed swiftlet, Eurasian tree-sparrow, cattle egret. While visiting FDM, or using FDM as stopover habitat along migration routes, these birds would be exposed to direct strike by munitions on FDM from strike warfare and firing exercises. Some birds may be killed or injured during these activities, or expend energy stores needed for migration to avoid perturbations generated by weapons firing.

There are a number of protective measures for FDM that minimize potential adverse impacts associated with weapons firing to Micronesian megapodes and habitats used by megapodes and other terrestrial animals. The protective measures were included in the 2010 USFWS Biological Opinion for the Navy's use of FDM (U.S. Fish and Wildlife Service 2010a). The measures include maintaining prohibitions on targeting the northern end of the island (which continues to support higher stature trees), placing of targets within impact areas, and maintaining prohibitions on the use of cluster bombs, bombs greater than 2,000 lb. NEW, fuel-air explosives, and incendiary devices.

Pursuant to the ESA, munitions strike on FDM during training activities under the No Action Alternative will not affect the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam rail, Guam Micronesian kingfisher, nightingale reed-warbler, Mariana common moorhen, Mariana crow, or Mariana swiftlet. Munitions strike may affect, and are likely to adversely affect, the Micronesian megapode and Mariana fruit bat on FDM.*

Critical Habitats on Guam or Rota will not be affected by munitions strike.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), munitions strike on FDM under the No Action Alternative will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

There are no testing activities that occur on land. Therefore, there are no potential impacts on terrestrial species or habitats.

3.10.3.2.2.2 Alternative 1

Training Activities

Table 3.0-22 lists the number of bombs, projectiles, missiles, and rockets that may be dropped on FDM under Alternative 1. The activities and type of military expended materials under Alternative 1 and would be expended in the same geographic locations as the No Action Alternative.

Specifically at FDM, the number of bombs, projectiles, missiles, and rockets targeting range portions of the island would increase by a factor of five. Most of these increases are associated with small caliber rounds (an increase from 2,900 under the No Action Alternative to 42,000 under Alternative 1). While increased ordnance use may increase exposure to direct strike, percussive force, and the direct and indirect effects of wild land fire, limiting ordnance use to existing impact areas (totaling 34 ac. [13.8 ha]) would minimize effects to Micronesian megapodes and transient Mariana fruit bats. Limiting explosive ordnance use to existing and defined impact areas will minimize effects on vegetation composition and structure outside of the impact zones. Therefore, impacts for the Micronesian megapode and the Mariana fruit bat are the same under Alternative 1 as with the No Action Alternative.

As described above, a few terrestrial bird species visit FDM, such as the fork-tailed swiftlet, Eurasian tree-sparrow, and cattle egret. While visiting FDM, or using FDM as stopover habitat along migration routes, exposure to munitions strike would increase under Alternative 1. Some birds may be killed or injured during these activities, or expend energy stores needed for migration to avoid perturbations generated by weapons firing. Breeding for these species does not occur on FDM, and these species are relatively common in other areas within the Mariana Islands. The death, injury, or disturbance of a few individuals of these species visiting FDM would not adversely affect populations.

Pursuant to the ESA, munitions strike on FDM during training activities under Alternative 1 would have no effect on the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam Micronesian kingfisher, nightingale reed-warbler, Mariana common moorhen, Mariana crow, or Mariana swiftlet. Munitions strikes may affect, and are likely to adversely affect, the Micronesian megapode and Mariana fruit bat on FDM.*

Critical Habitats on Guam or Rota will not be affected by munitions strike.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), munitions strike on FDM under Alternative 1 will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

Under Alternative 1, there are no testing activities that would involve weapons firing on land or toward land-based targets. Therefore, there would be no potential strike of wildlife or plant species from weapons firing during testing activities under Alternative 1.

3.10.3.2.2.3 Alternative 2

Training Activities

Appendix A (Activities Descriptions) lists the training and testing activities that use ordnance on FDM. The number of ordnance use on FDM is summarized for Alternative 2 in Table 3.0-22. The activities and type of military expended materials under Alternative 2 and would be expended in the same geographic locations as the No Action Alternative.

As with Alternative 1, the number of bombs, projectiles, missiles, and rockets targeting range portions of FDM would increase by a factor of five. Alternative 2 differs from Alternative 1 in that 579 more bombs up to 2,000 lb. NEW would be dropped on FDM. As with Alternative 1, most of these increases in ordinance use on FDM are associated with small caliber rounds (an increase from 2,900 under the No Action Alternative to 42,000 under Alternative 2). Limiting explosive ordnance use to existing and defined impact areas will minimize effects on vegetation composition and structure outside of the impact zones. Therefore, impacts for the Micronesian megapode and the Mariana fruit bat are the same under Alternative 2 as with the No Action Alternative.

As described above, a few terrestrial bird species visit FDM, such as the fork-tailed swiftlet, Eurasian tree-sparrow, cattle egret. While visiting FDM, or using FDM as stopover habitat along migration routes, exposure to munitions strike would increase under Alternative 2. These birds would be exposed to more bomb fragments under Alternative 2, relative to Alternative 1. Some birds may be killed or injured during these activities, or expend energy stores needed for migration to avoid perturbations generated by weapons firing. Breeding for these species does not occur on FDM, and these species are relatively common in other areas within the Mariana Islands. The death, injury, or disturbance of a few individuals of these species visiting FDM would not adversely affect populations.

Pursuant to the ESA, munitions strike on FDM during training activities under Alternative 2 would have no effect on the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam Micronesian kingfisher, nightingale reed-warbler, Mariana common moorhen, Mariana crow, or Mariana swiftlet. Munitions strikes may affect, and are likely to adversely affect, the Micronesian megapode and Mariana fruit bat on FDM.*

Critical Habitats on Guam or Rota will not be affected by munitions strike.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), munitions strike on FDM under Alternative 2 will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

Under Alternative 2, there are no testing activities that would involve weapons firing on land or toward land-based targets. Therefore, there would be no potential strike of wildlife or plant species from weapons firing during testing activities under Alternative 2.

3.10.3.2.3 Impacts from Ground Disturbance

This section assesses the potential of ground disturbing activities, such as vehicular and pedestrian movements as part of land navigation training and field training exercises. As shown in Table 2.8-1, these exercises may occur on Guam (Southern Land Navigation Area and Northern Land Navigation Area within Naval Munitions Storage), within Tinian MLA, within the Marpi Maneuver Area on Saipan, and north of the no-fire line on FDM (associated with direct action tactical air control training activities).

3.10.3.2.3.1 No Action Alternative

Training Activities

Under the No Action Alternative, ground disturbance could result from vehicular movements and pedestrian foot traffic as part of field training exercises, airfield seizure activities, and airfield expeditionary training activities. See Table 2.8-1 for a list of these training activities and locations within the Study Area, and the annual estimate of how many exercises would occur under the No Action Alternative.

Field training exercises would occur in areas known to support foraging swiftlets and their roosting and nesting caves. However, the Navy does not train within 328.1 ft. (100 m) of a cave entrance on Guam, and no training will occur within or near caves on Saipan. No foraging habitat (forests or grasslands in which they fly over to capture insects) will be removed due to training, and overflight restrictions are in place to minimize disturbance to fruit bats, moorhens, and swiftlets. The use of incendiary training materials is limited such that fires in forested habitats are unlikely.

On Tinian, non-ESA listed forest birds use limestone forests and tangantangan thickets within the Tinian MLA. Micronesian megapode habitat is found in relatively intact limestone forest areas and in associated edge habitats. Megapode detections are rare on Tinian, and the first megapode sighting in recent years occurred in the spring of 2013 (U.S. Department of the Navy 2013a). However, there are no recent records of megapodes and no nesting records (Kessler and Amidon 2009). Any megapodes utilizing Tinian habitats are most likely transients. Although increased land maneuvers may increase the potential for inadvertent trampling of megapodes by troops moving through the area, the limited sightings of megapodes on Tinian during surveys makes any potential adverse effects unlikely. There are also a number of bird species not listed under the ESA that reside on Tinian. The rufous fantail, Micronesian starling, Tinian monarch, and bridled white-eye nest within the Tinian MLA in both tangantangan thickets and mature limestone forests found along cliffs. As most field training exercises are expected to occur on hardened surfaces, impacts to vegetation communities and species using these areas as habitats are not expected. Some field exercises, however, may occur in tangantangan forests surrounding the airfield. Further, there are training area restrictions that prohibit military training activities in ecologically sensitive areas (e.g., Hagoi and other wetlands within the Tinian MLA), where Mariana common moorhens nest and forage, along with other native terrestrial birds, migrants, and potential Mariana fruit bats in the vegetation surrounding the wetlands and in intact limestone forests (U.S. Department of the Navy 2013a).

On Saipan, the nightingale reed-warbler and non-ESA listed forest bird species may utilize portions adjacent to or within pedestrian maneuver areas for army reserve units. Training within the Marpi tract is expected to be infrequent and limited to pedestrian land navigation training in open areas. Training restrictions during peak breeding periods (April through June and October through December) will be implemented to the maximum extent practical. Non-ESA listed forest birds described in Section 3.10.2.1.4 (Saipan Marpi Maneuver Area) will not be impacted because of the infrequent use of the area by military personnel.

On FDM, limited pedestrian traversing would occur near the helicopter landing zone, as part of direct action tactical air control training activities. Under the No Action Alternative, three direct action activities would occur on FDM. Because traversing the site would be limited between the control tower and the landing zone, it is unlikely that this limited pedestrian traffic would cause any ground disturbance or damage vegetation. Micronesian megapodes north of the no-fire line would likely experience temporary behavioral impacts (moving away from personnel), but the disturbance would likely have already occurred due to the approach and departure of the helicopter transporting the direct action personnel. Because of the limited nature of the ground disturbance activities associated with this direct action training type, and the infrequent occurrence of the activity on FDM, impacts are expected to be limited to temporary behavioral impacts with no injury or mortality to megapodes.

Pursuant to the ESA, ground disturbance resulting from land and field training exercises under the No Action Alternative will not affect the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam Micronesian kingfisher, Mariana crow, Mariana common moorhen, or Mariana fruit bat. Ground disturbance may affect, but not likely adversely affect the Mariana swiftlet, Micronesian megapode, and the nightingale reed-warbler.*

Critical Habitats on Guam or Rota will not be affected by ground disturbing activities.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), ground disturbance resulting from land and field training exercises under the No Action Alternative will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

Under the No Action Alternative, no testing events would occur on land or impact terrestrial species or habitats.

3.10.3.2.3.2 Alternative 1 and Alternative 2

Under both Alternatives 1 and 2, direct action trainings on FDM would increase to 18 per year. This would increase exposures of megapodes and fruit bats to pedestrian traffic; however, traversing the site would be limited to the area surrounding the helicopter landing zone, north of the "no fire line." Because of the limited nature of the ground disturbance activities associated with this direct action training type, and the infrequent occurrence of the activity on FDM, impacts are expected to be limited to temporary behavioral impacts with no injury or mortality to megapodes.

Pursuant to the ESA, ground disturbance resulting from land and field training exercises under Alternative 1 or Alternative 2 would have no effect on the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam Micronesian kingfisher, Mariana crow, Mariana common moorhen, or Mariana fruit bat. Ground disturbance may affect, but not likely adversely affect, the Mariana swiftlet, Micronesian megapode, and the nightingale reed-warbler.*

Critical Habitats on Guam or Rota will not be affected by ground disturbing activities.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), ground disturbance resulting from land and field training exercises under Alternative 1 or Alternative 2 will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

There are no testing activities that involve ground disturbance; therefore, testing activities will have no impact on terrestrial species or habitats.

3.10.3.2.4 Impacts from Wildfires

This section provides an assessment of wildfire potential associated with training activities in land training areas within the Study Area, and how wildfires could impact species and habitats. The only location within the Study Area where wildfires could be caused by training activities is at FDM.

Training (foot and vehicle land navigation, sniper training, small field exercises) in the Northern Land Navigation Area and other areas of the Naval Base Guam Munitions Site, as well as with field training exercises within the Andersen AFB, Tinian MLA, and Saipan Marpi Maneuver Area, could start a wildfire; however, the use of incendiary training materials is limited such that fires in forested habitats are unlikely. A fire management plan was developed by the U.S. Forest Service to minimize impacts associated with wildland fires (U.S. Department of the Navy 2009). To date, no wildland fires have been ignited within the Naval Munitions Storage Site due to military activity. Fires that have burned areas within the Naval Base Guam Munitions Storage Site originated off DoD properties and were generally associated with trash burning (U.S. Department of the Navy 2009). In addition, the existing configuration of firebreaks and road networks generally confines fires to upland savanna portions of the Naval Munitions Storage site so they do not reach wetland habitats (U.S. Department of the Navy 2009). Wildfires on Andersen AFB are less frequent, and none have been attributed to training exercises (U.S. Department of the Navy 2009).

The Tinian MLA, particularly around Tinian North Field, is composed of large areas of tangantangan, secondary forest, and open fields. Grass fires are common on Tinian and are more likely to occur during the dry season. Most fires are intentionally lit. Fires initiated in open fields have the potential to persist when forest habitat is reached, resulting in a direct threat to federally listed species (U.S. Department of the Navy 2009). Incidental sightings of intentionally set fires have occurred in the Tinian MLA. Some speculate the fires may have been started by locals to facilitate collection of coconut crabs or scrap metal (U.S. Department of the Navy 2013a). There are no records of wildfires on Tinian resulting from U.S. military training activities (U.S. Department of the Navy 2009).

The potential impacts of wildfire on terrestrial species and habitats will focus on FDM, where the use of live fire and explosive munitions is authorized. Fire season should be considered year-round at FDM; however, fuel loading (the amount of flammable vegetation) and ignition potential would increase during the dry season. Fire danger increases during the dry season (February through April) and decreases in the wet season (July through October). Wildland fires can set back succession within vegetation communities and facilitate establishment of fire-tolerant species, which may alter the composition and structure of vegetation communities. Fires may cause direct mortality of birds and nests in vegetated areas with fuel loadings sufficient to carry fire, and indirect mortality through exposure to smoke or displacement of nest predators into nesting habitats.

Fire can indirectly affect wildlife at FDM by changing the physical and biological characteristics of the area, which subsequently degrades habitats and reduces the forage base. Physical features that will be exposed to heat and flames include soil structure and microclimate conditions. Fire has been shown to increase soil temperatures, alter soil moisture holding capacity, and modify soil rainfall infiltration (Neary et al. 2005). These physical features are indirectly exposed to post-fire erosion and alterations of light and shade, temperature, humidity, and wind as a result of vegetation destruction. Light levels, temperatures, and wind speeds will increase with destruction of canopy plants, and relative humidity will decrease (Hoffmann et al. 2003). Because vegetation cover affects erosion rate, soil erosion may occur after fire except where rapid establishment of non-native invasive grasses are prevalent. Grass invasion may occur following removal of shrub and tree canopy (D'Antonio and Vitousek 1992; Tunison et al. 2001). Chemical features that will be exposed to heat, flames, smoke, and ash include soil nutrients and water, which will be indirectly exposed to post-fire changes in content and cycling rates. Soil nutrient availability will be altered through volatilization of certain elements to the atmosphere in smoke (e.g., carbon, nitrogen, and sulfur), conversion to more available forms in the ash (e.g., potassium, phosphorus, and divalent cations), wind dispersal of the ash, and surface erosion (Agee 1993).

Biotic features of the habitat that will be exposed to heat, flames, smoke, and ash include all living organisms in the exposure area, litter layers on the forest floor, organic matter within the surface soil horizon, and seeds within the litter and surface soil. These types of organic matter are typically used in megapode nests for incubation of eggs via heat from decomposition. Forage organisms will be directly exposed to injury or death, and seeds, litter, and organic matter will be directly exposed to destruction and loss (Cochrane 2003). These effects, in turn, will indirectly expose soil to long-term changes in fertility and structure as a result of disrupted decomposition and nutrient cycling processes, reduced nutrient and water retention by organic matter, increased nutrient losses in runoff and leaching, and reduced ecosystem primary production due to loss of leaf area and photosynthesis (Cochrane 2003).

As discussed in Section 3.10.2.1.5 (Farallon de Medinilla) and evidenced in Figure 3.10-4, military bombardment has reduced forested portions of FDM, primarily within impact areas. Forests can continue to degrade as ground cover loses canopy closure, thereby reducing fuel moisture content in vegetation and facilitating fires spreading into areas outside the impact areas. Further, invasive herbaceous vegetation can quickly colonize the newly opened habitats, which increases fine fuel loading and the ability of fires to spread. The potential for military bombardment of FDM to alter vegetation composition and structure was noted during post-bombardment surveys conducted in August 1997. These surveys revealed 25 to 50 fresh bomb craters and a large section of the island burned to bare earth (Lusk et al. 2000; U.S. Fish and Wildlife Service 1998).

Based on surveys conducted in 1974 (as discussed in Section 3.10.2.1.5, Farallon de Medinilla), recent assessments in 2000 (Lusk et al. 2000), and current surveys of FDM’s avifauna and knowledge of FDM’s vegetation community status (U.S. Department of the Navy 2013a), the vegetation and avian communities have changed significantly since 1974. Prior to intensive military use of the island, the presence of more trees with a higher canopy resulted in a higher number of terrestrial birds and tree nesting seabirds (Lusk et al. 2000).

3.10.3.2.4.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

Training activities that involve high explosive detonations on FDM introduce the potential for wildfires on the island. The number of training activities using explosives at FDM is presented in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives). Although the use of ordnance with high explosives increases from the No Action Alternative to Alternative 1, and from the No Action Alternative to Alternative 2, the potential for wildfire is the same for all alternatives.

Cluster bombs, live cluster weapons, live scatterable munitions, fuel-air explosives, incendiary devices, and bombs greater than 2,000 lb. are prohibited on FDM. The live-fire weapons allowed are only used in two specific areas and targets are placed to reduce the potential for wildfire. The areas for target placement only support low growing vegetation because of long-term training with explosives. Due to the lack of fuels in the area, explosions have not resulted in wildfires. Dense vegetation grows on the northern portion of the island within the "No Drop Zone," which could create a wildfire if weapons are misfired. However, this dense vegetation and shaded canopy of trees in the northern portion of the island likely increases the moisture content of vegetation, thereby decreasing the ability of fires to spread north of the "No Fire Line."

Mariana fruit bat sightings are very rare on FDM—the last sighting, of a single fruit bat, was reported in 2008 (U.S. Department of the Navy 2013a). Catastrophic events within the Mariana archipelago may temporarily cause populations of fruit bats to fluctuate on different islands, although some movement between islands seems to be a natural occurrence. These events may result from typhoons, poaching, or volcanic eruptions. Catastrophic events and other factors may cause Mariana fruit bat populations on FDM to temporarily increase, thereby exposing transient and permanent resident bats to potential harassment and harm associated with live-fire training. FDM may support a small number of year-round residents, and Mariana fruit bats can be assumed to utilize FDM as a resting point for longer inter-island movements. Due to infrequent transient use of FDM by Mariana fruit bats, and the location of likely foraging and roosts confined to the northern portion of the island (north of the "no fire zone"), impacts associated with wildfires occurring primarily in the central portion of the island would be unlikely.

As described above, munitions use on FDM can ignite wildfires. Wildfire intensity may vary based on the amount and type of munitions, wind speed, levels of humidity, seasonal variation in vegetation thickness and composition, and successional state of vegetation. Micronesian megapodes on FDM would be expected to fly away from smoke, but exposure to smoke inhalation would result in some form of respiratory distress (U.S. Fish and Wildlife Service 2010a). Direct mortality of megapodes could result from intensive respiratory distress or encirclement of burning vegetation. Megapode eggs, even in burrows, would not likely survive a wildfire overburn on FDM. Likewise, any fledglings within a burn area would be expected to suffer intensive respiratory distress, unable to flee smoke or burning vegetation. As stated above, fires are unlikely to spread to the northern portion of FDM; therefore, the northern portion of the island would continue to serve as refugia for Micronesian megapodes that either reside in this area or for megapodes able to flee smoke and flames from target areas.

Pursuant to the ESA, wildfires resulting from explosive munitions and bombardment of FDM under the No Action Alternative, Alternative 1 or Alternative 2 will not affect the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam Micronesian kingfisher, Mariana crow, Mariana common moorhen, Mariana swiftlet, or nightingale reed-warbler. Wildfires may affect, but not adversely affect the Mariana fruit bat. Wildfires may affect and are likely to adversely affect, Micronesian megapodes on FDM.*

Critical Habitats on Guam or Rota will not be affected by ground disturbing activities.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), wildfires resulting from explosive munitions and bombardment of FDM under the No Action Alternative, Alternative 1 or Alternative 2 will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

No testing activities are included under the No Action Alternative. No testing activities for Alternative 1 or Alternative 2 involve munitions use at FDM. There are no impacts to terrestrial species and habitats from testing activities that use munitions.

3.10.3.3 Secondary Stressors

This section summarizes how secondary stressors (stressors that are not directly part of activities) can potentially impact terrestrial habitats and species. Specifically, this section addresses the potential of water quality stressors, air quality stressors, and for training activities to degrade island habitats within the Marianas through the accidental introduction of invasive species. Section 3.10.3.3.1 (Impacts from Invasive Species Introductions) discusses potential introduction pathways of invasive species associated with training activities described in this EIS/OEIS.

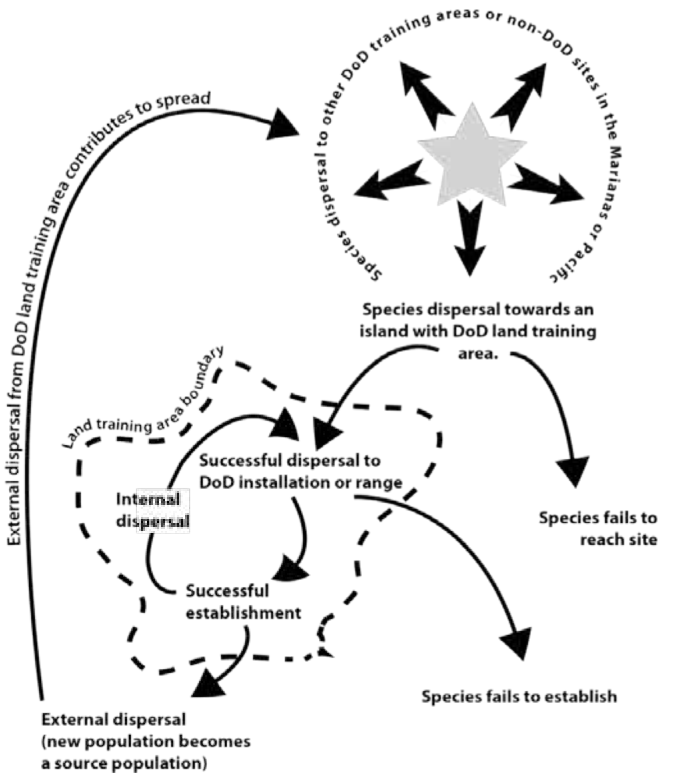
3.10.3.3.1 Impacts from Invasive Species Introductions

In general, a species introduction to terrestrial environments on Guam and the CNMI may be described in stages. First, species established in other areas or from their native ranges enter into dispersal pathways. As an example, pathways may include transportation modes (such as landing gear of airplanes or within cabin or cargo holds) or commercial pathways (trade in seeds, plant material, or animals). A second stage of the invasion process is the live release of species which, depending on the mode of introduction, is important because most species do not survive the transport (Thompson and Davis 2011). A third stage of invasion is that populations of species establish and adapt to new environments (Davis 2009). Figure 3.10-9 shows the general steps involved in the establishment and spread of invasive species associated with military training in the Marianas.

Pathways of invasive species associated with military training activities include various transport modes, such as marine transport (e.g., ballast water releases, biofouling of ship hulls), air transport (organisms transported in aircraft cabins, cargo holds, or landing gear), or land transports during intra-island movements (e.g., transporting of organisms from one training area to another attached to unclean vehicles). Personnel movements can also present introduction pathways. For instance, organisms (such as seed or other plant materials) can be transported on clothing or in gear. Figure 3.10-10 shows the potential introduction pathways of invasive species to terrestrial habitats associated with each warfare area identified in Chapter 2 (Description of Proposed Action and Alternatives).

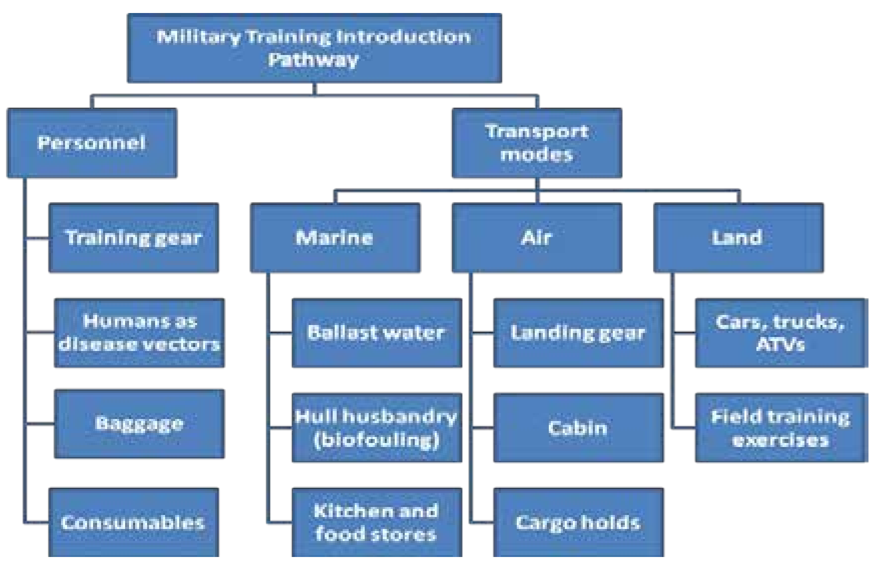
The Navy cooperates with the USFWS, the U.S. Department of Agriculture Animal and Plant Health Inspection Service, and the U.S. Department of Agriculture Wildlife Services, as well as other government agencies and working groups to identify pathways associated with military activities in the Marianas. After identifying pathways associated with a particular activity, risks are reduced by implementing policies and procedures to reduce the likelihood of species to occur within a particular introduction pathway. For instance, all troops involved in training activities in land areas of the Study Area conduct self inspections to avoid potential introductions of invasive species to Guam and the CNMI. Troops inspect all gear and clothing (e.g., boots, bags, weapons, and pants) for soil accumulations, seeds, invertebrates, and possible inconspicuous stowaway brown treesnakes). The intent of this measure is to minimize the number of potentially invasive species in introduction pathways (U.S. Department of the Navy 2009; U.S. Fish and Wildlife Service 2010a).

The Navy also complies with DoD Transportation Regulations, Chapter 505 protocols, by implementing a 100 percent inspection of all outgoing vessels and aircraft with dog detection teams to meet 100 percent inspection goals for large-scale training activities (U.S. Department of Defense 2011). To mitigate the limited inspection capability of the U.S. Department of Agriculture Wildlife Service, the Navy notifies point of destination port or airport authorities in the event military units, vehicles, and equipment leave Guam without inspection.



Source: Modified and adapted from Davis (2009)

Figure 3.10-9: Invasive Species Invasion Process Associated with Military Training in the Marianas



Source: Adapted from Lodge et al. (2006)

Figure 3.10-10: Potential Introduction Pathways of Invasive Species Associated with Military Training in the Marianas

In addition, the Navy routes inbound personnel and cargo for tactical approach exercises that require an uninterrupted flow of events direct to CNMI training locations to avoid Guam seaports and airfields to the extent possible. For example, a Hawaii-based unit destined to Tinian for anti-terrorism/urban warfare type training will travel direct to Tinian and only through Guam on the outbound journey.

Further, the Navy provides extensive funding for brown treesnake eradication efforts and research by other agencies. The Navy is also establishing quarantine areas for outbound cargo traveling from Guam to CNMI and locations outside the MITT Study Area.

3.10.3.3.1.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

The No Action Alternative, Alternative 1, and Alternative 2 do not introduce additional pathways for invasive species to enter, establish, and spread from DoD installations and ranges within the Study Area. Further, protective biosecurity measures employed by the Navy reduce the number of invasive species within existing potential introduction pathways. In conclusion, training activities under the No Action Alternative, Alternative 1, or Alternative 2 would not increase risks to vegetation communities, wildlife resources, or ESA-listed species or habitats within the Study Area.

Pursuant to the ESA, secondary stressors associated with potential invasive species introductions to terrestrial habitats resulting from training activities under the No Action Alternative, Alternative 1, or Alternative 2 will not affect the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam Micronesian kingfisher, Mariana crow, Mariana common moorhen, Mariana fruit bat, Mariana swiftlet, nightingale reed-warbler, or Micronesian megapode.*

Secondary stressors will not affect Critical Habitats on Guam or Rota.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), secondary stressors associated with potential invasive species introductions to terrestrial habitats resulting from training activities under the No Action Alternative, Alternative 1, or Alternative 2 will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

Because there are no testing activities associated with land-based training, testing activities would not introduce secondary stressors in terrestrial habitats and would not impact terrestrial biological resources.

3.10.3.3.2 Impacts from Water and Air Quality Stressors

The potential for water and air quality stressors associated with training and testing activities to indirectly affect terrestrial biological resources as secondary stressors were analyzed. The assessment of potential water and air quality stressors are in Section 3.1 (Sediments and Water Quality) and Section 3.2 (Air Quality); the assessment addresses specific activities in local environments that may affect terrestrial species and habitats.

3.10.3.3.2.1 No Action Alternative, Alternative 1, and Alternative 2

Training Activities

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 terrestrial species or habitats.

Pursuant to the ESA, secondary stressors associated with impacts to water and air quality resulting from training activities under the No Action Alternative, Alternative 1, or Alternative 2 will not affect the Serianthes *tree,* Osmoxylon mariannense*,* Nesogenes rotensis*, Rota bridled white-eye, Guam Micronesian kingfisher, Mariana crow, Mariana common moorhen, Mariana swiftlet, nightingale reed-warbler, or Micronesian megapode. Secondary stressors may affect and are likely to adversely affect, Micronesian megapodes on FDM.*

Secondary stressors will not affect Critical Habitats on Guam or Rota.

Under the MBTA regulations applicable to military readiness activities (50 C.F.R. Part 21), secondary stressors associated with impacts to water and air quality resulting from training activities under the No Action Alternative, Alternative 1, or Alternative 2 will not result in significant adverse effects on terrestrial bird populations.

Testing Activities

Because there are no testing activities associated with land-based training, testing activities would not introduce secondary stressors in terrestrial habitats and would not impact terrestrial biological resources.

3.10.4 Summary of Potential Impacts on Terrestrial Species and Habitats

3.10.4.1 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 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 are summarized in Section 3.10.4.2 (Endangered Species Act Determinations).

There are generally two ways a terrestrial biological resource could be exposed to multiple stressors. The first would be if, for example, an animal 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 from each of the stressors and the response or lack of response to that stressor. Most activities as described in the Proposed Action involve multiple stressors; therefore, it is likely that if a receptor 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).

Secondly, an individual animal 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., air to ground ordnance drops at FDM, aircraft take offs and landings at Andersen AFB, and routine activity locations) and in areas that individual animals frequent because it is within the animal's home range, migratory route, breeding area, or foraging area. Except for 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 animal would be exposed to stressors from multiple activities. However, animals with a small home range intersecting an area of concentrated military activity have elevated exposure risks relative to animals that simply transit the area through a migratory route. The majority of the proposed training and testing activities has few participants, and are of a short duration (the order of a few hours or less).

Multiple stressors may also have synergistic effects. For example, terrestrial animals 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. Animals 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 military stressors, the synergistic impacts from the combination of military stressors on terrestrial animals are difficult to predict.

Although potential impacts on 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). Potential impacts anticipated from the Proposed Action are summarized in Section 3.10.4.2 (Endangered Species Act Determinations).

3.10.4.2 Endangered Species Act Determinations

Based on the type of activities in the various land training areas of the MITT Study Area, the Navy presents the following summary of effects determinations to ESA-listed species and Critical Habitats.

3.10.4.2.1 Critical Habitats

3.10.4.2.1.1 Critical Habitats on Guam

Critical Habitat designations on Guam for the Mariana crow, Mariana fruit bat, and Micronesian kingfisher are confined to the terrestrial portions of the Guam National Wildlife Refuge fee simple portion (Ritidian Unit). Because training does not occur within the Ritidian Unit and there is no need for training to access the portion of the road that descends Ritidian Cliff to the Ritidian Unit, the Navy concludes that training and testing activities would have no effect on designated Critical Habitat on Guam.

3.10.4.2.1.2 Critical Habitats on Rota

Critical Habitat designations on Rota for the Mariana crow and Rota bridled white-eye occur entirely within areas where the Navy does not train; therefore, the Proposed Action would have no effect on or represent an adverse modification to the designated Critical Habitat units on Rota and would not disturb the various primary constituent elements. The Navy concludes that the designated Critical Habitat avoidance, invasive species interdiction, and control measures (described in Chapter 5) are sufficient to not affect designated Critical Habitat on Rota.

3.10.4.2.2 Summary of Endangered Species Act Effects Determinations

In 2010, the USFWS Pacific Islands Fish and Wildlife Office issued a Biological Opinion, pursuant with Section 7 of the ESA, on proposed training activities within the MIRC. The Biological Opinion concluded that training activities within the Study Area would have no effect on the *Serianthes nelsonii*, *Osmoxylon mariannense*, *Nesogenes rotensis*, Guam Micronesian kingfisher, Guam rail, Mariana crow, Rota bridled white-eye, or critical habitat units on Guam and Rota. The Biological Opinion also concluded that training activities may affect, but are not likely to adversely affect, the Nightingale reed warbler, Mariana swiftlet, and Mariana common moorhen. The Biological Opinion concluded that training activities may affect, and are likely adversely affect, Micronesian megapode and the Mariana fruit bat. The Action Area (the area considered in the Section 7 ESA consultation, subject to direct and indirect effects) for the Biological Opinion issued by the USFWS in 2010 is the same area considered for analysis in this EIS/OEIS. Table 3.10-7 summarizes the ESA determinations for each substressor analyzed in this EIS/OEIS. The Navy and USFWS will be conducting a Section 7 consultation since the current Biological Opinion will expire in August 2015.

The Navy also conducted an analysis of potential effects for seven species considered to be candidates for ESA listing. These species include the Mariana eight-spot butterfly, the Mariana wandering butterfly, the humped tree snail, the Guam tree snail, the fragile tree snail, the Langford tree snail, and the Pacific sheath-tailed bat. These species do not co-occur with military training activities described in this EIS/OEIS, either because the species has been extirpated from military training areas or because the species is confined to habitats within military properties or lease areas where training does not occur. Therefore, military training activities described in this EIS/OEIS will have no effect on species considered to be candidates for ESA listing.

3.10.4.3 Migratory Bird Treaty Act Determinations

Under the MBTA 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. While this determination is applicable to all terrestrial birds that occur in the Study Area, the Navy carried out a focused analysis for native land birds known to breed within the Study Area.

Pursuant with the DoD's obligations under 50 C.F.R. Part 21, the DoD will continue to implement training restrictions on FDM (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring), monitoring of bird populations on FDM, and other natural resource projects described in the Joint Region Marianas Integrated National Resource Management Plan specifically designed to benefit native terrestrial birds (U.S. Department of the Navy 2013a).

Table 3.10-7: Summary of Endangered Species Act Effects Determinations for Endangered Species Act-Listed Terrestrial Species

Navy Activities and Stressors	Hayun Lagu (*Serianthes* tree)	Ko'ko' (Guam rail)	Sihek (Guam Micronesian kingfisher)	Pulattat (Mariana common moorhen)	Aga (Mariana crow)	Fanihi (Mariana fruit bat)	Yayaguak (Mariana swiftlet)	Sasangat (Micronesian megapode)	Ga'ga' Karisu (nightingale reed-warbler)	Nosa Luta (Rota bridled white-eye)
Acoustic Stressors										
Explosives, weapons firing, launch, and impact noise	NE	NE	NE	NE	NE	LAA	NE	LAA	NE	NE
Aircraft noise	NE	NE	NE	NLAA	NLAA	NLAA	NLAA	NLAA	NE	NE
Physical Stressors										
Aircraft and aerial target strike	NE	NE	NE	NLAA	NE	NLAA	NE	NE	NE	NE
Military expended materials	NE	NE	NE	NE	NE	NLAA	NE	LAA	NE	NE
Ground disturbance	NE	NE	NE	NE	NE	NE	NLAA	LAA	NLAA	NE
Wildfires	NE	NE	NE	NE	NE	NE	NE	LAA	NE	NE

Notes: NE = No effect; NLAA = May affect, not likely to adversely affect; LAA = May affect, likely to adversely affect

REFERENCES

Agee, J. K. (1993). Fire ecology of Pacific northwest forests (pp. 493). Washington, D.C.: Island Press.

Amar, A., Amidon, F., Arroyo, B., Esselstyn, J.A., Marshall, A.P. (2008). Population trends of the forest bird community on the Pacific Island of Rota, Mariana Islands. *The Condor 110*(3): 421-427.

Air Force Safety Center. (2007). Bird/Wildlife Aircraft Strike Hazard (BASH). Retrieved from http://www.afsc.af.mil/organizations/bash/, 29 February 2012.

Amidon, F. A. (2009). Tinian Monarch Surveys *in: Terrestrial Resource Surveys of Tinian and Aguiguan, Mariana Islands, 2008, Working Draft*. (pp. 94-206). Honolulu, Hawaii.

Beauprez, G. M. & Brock, K. (1999). Establishment of an Experimental Population of Guam Rails on Rota or Other Islands in the Marianas. Job Progress Report Research Project Segment, Project Number E-2-2. Mangalao, Guam. Prepared for Guam Department of Agriculture, Division of Aquatic and Wildlife Resources.

Bies, L., T. B Balzer, & W. Blystone. (2006). Pocosin Lakes National Wildlife Refuge: Can the Military and Migratory Birds Mix? *Wildlife Society Bulletin, 34*, 502-503.

Brooke, A. (2012). Joint Region Marianas. Status of the wedge-tailed breeding colony on Managaha Island (off Saipan), CNMI. Comments provided in document review T. Houston, SRS-Parsons Joint Venture, January 16, 2012.

Brown, V.A, A. Brooke, J.A. Fordyce, & G.F McCracken. (2011). Genetic analysis of populations of the threatened bat *Pteropus mariannus. Conservation Genetics,* 12: 933-941.

Buchannan, J. B. (2011, December). Collisions and In-Flight Calamities Involving Shorebirds in Westernn Washington. *Washington Birds, 11*, 22-27.

Camp, R.J., T. K. Pratt, A. P. Marshall, F. Amidon, & L. L. Williams. (2009). Recent status and trends of the land bird avifauna on Saipan, Mariana Islands, with emphasis on the endangered nightingale reed-warbler *Acrocephalus luscinia*. *Bird Conservation International, 19*, pp 323-337.

Camp, R. J., F. A. Amidon, A. P. Marshall, & T. K. Pratt. (2012). Bird populations on the island of Tinian: Persistence despite Wholesale Loss of Native Forests. *Pacific Science, 66:* 283-298

Christy, M. T., J. A. Savidge, and G. H. Rodda. (2007a). Multiple pathways for invasion of anurans on a Pacific island. *Diversity and Distributions,* 13:598 – 607.

Christy, M. T., C. S. Clark, D. E. Gee II, D. Vice, D. S. Vice, M. P. Warner, C. L. Tyrrell, G. H. Rodda, & J. A. Savidge. (2007b). Recent records of alien anurans on the Pacific island of Guam. *Pacific Science,* 61:469 – 483.

Cochrane, M. A. (2003). Fire science for rainforests. *Nature, 421*(5), 912-919.

Commonwealth of the Northern Mariana Islands Division of Fish and Wildife. (2005). Comprehensive Wildlife Conservation Strategy For the Commonwealth of the Northern Mariana Islands. Saipan, CNMI. Prepared by J. G. G. G. M. Berger, G. Schroer.

Corwin, J. T. & Cotanche, D. A. (1988). Regeneration of sensory hair cells after acoustic trauma. *Science, 240*, 1772-1774.

Craig, R.J. (1992). Territoriality, habitat use, and ecological distinctness of an endangered Pacific island reed-warbler. Journal of Field Ornithology 63:436-444.

Craig, R.J. & Taisacan., E. (1994). Notes on the ecology and population decline of the Rota Bridled White-eye. *Wilson Bulletin 106*:165-168.

Cruz, J., Arriola, L., Johnson, N. & Beauprez, G. (1999). Wildlife and Vegetation Surveys, Tinian Conservation Areas. (Technical Report #1, pp. 12). Prepared for Commonwealth of the Northern Mariana Islands Division of Forestry and Wildlife.

Cruz, J., Arriola, L., Johnson, N. & Beauprez, G. (2000). Wildlife and Vegetation Surveys, Aguiguan 2000. (Technical Report #2). Prepared for Commonwealth of the Northern Mariana Islands Division of Forestry and Wildlife.

Cruz, J., Arriola, L., Johnson, N. & Beauprez, G. (2002). Wildlife and Vegetation Surveys, Aguiguan 2002. (Technical Report #9). Prepared for Commonwealth of the Northern Mariana Islands Division of Forestry and Wildlife.

Cruz, J.B., S.R. Kremer, G. Martin, L.L. Williams, and V.A. Camacho. (2008). Relative abundance and distribution of Mariana swiftlets (Aves: Apodidae) in the Northern Mariana Islands. *Pacific Science. 62:* 233-246.

D'Antonio, C. M. & Vitousek, P. M. (1992). Biological invasions by exotic grasses, the grass fire cycle, and global change. *Annual Review of Ecology and Systematics 23*, 63-87.

Davis, M. (2009). Invasion Biology. Oxford, UK: Oxford University Press.

Dolbeer, R. A. (2006). Height Distribution of Birds Recorded by Collisions with Civil Aircraft U. o. N.-. Lincoln (Ed.), *Wildlife Damage Management Internet Center for Publications*. (pp. 7). Lincoln, Nebraska: U.S. Department of Agriculture Wildlife Services.

Donnegan, J. A., Butler, S. L., Grabowiecki, W., B A Hiserote & Limtiaco, D. (2004). Guam's forest resources, 2002. (Resour. Bull. PNW-RB-243). Prepared for U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR. 32 pp.

Epstein, J. H., Olival, K. J., Pulliam, J. R. C., Smith, C., Westrum, J., Hughes, T., Dobson, A.P., Zubaid, A., Rahman, S.A., Basir, M.M., Field, H.E., & Daszak, P. (2009). Pteropus vampyrus, a hunted migratory species with a multinational home-range and a need for regional management. *Journal of Applied Ecology 2009, 46, 991–1002, 46*, 991-1002.

Federal Aviation Administration. (2003). Memorandum of Agreement Between the FAA, the USAF, the U.S. Army, the USEPA, the USFWS, and the U.S. Department of Agriculture (USDA) to Address Aircraft-Wildlife Strikes. Retrieved from http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/birdstrikes.pdf, 16 January 2012.

Fosberg, F. R. (1960). The vegetation of Micronesia. *American Museum of Natural History Bulletin, 119*, 1-75.

Fritts, T. H. & Leasman-Tanner, D. (2001). The Brown Treesnake on Guam: How the arrival of one invasive species damaged the ecology, commerce, electrical systems, and human health on Guam: A comprehensive information source. Retrieved from http://www.fort.usgs.gov/resources/education/bts/bts_home.asp, November 2, 2011.

Glass, P. & Taisacan, E. M. (1988). Marianas fruit bat surveys and research *in: Five Year Progress Report, Fiscal Year 1982-87*. Pittman-Robertson Federal Aid in Wildlife Restoration Program. Prepared for Division of Fish and Wildlife, Commonwealth of the Northern Mariana Islands.

Google Earth 5.1. (2012). Image acquired from Google Earth application.

Guam Division of Aquatic and Wildlife Resources. (2006). Guam Comprehensive Wildife Conservation Strategy. Mangalao, Guam. Prepared by D. L. C. F. Aguon, L. Dicke, L. Henderson.

Hamby, W. (2004). Ultimate Sound Pressure Level Table. Retrieved from http://www.makeitlouder.comlDeci bel %2 OLevel %2 OChart. txt, 1 March 2012.

Hawley, N. B. & Castro, A. (2008). Candidate Butterflies *in: U.S. Fish and Wildlife Service Report, Terrestrial Resource Surveys of Tinian and Aguiguan Islands*.

Herod, H. & William, L. (2008). Re-establishment of the Saipan Upland Mitigation Bank. Presented at the Brown Treesnake Technical Working Group Meeting, Hawaii Prince Hotel, Honolulu, Hawaii April 16-18, 2008.

Hess, S.C. & Pratt, L.W. (2006). Final Integrated Trip Report—Site Visits to Area 50, Andersen Air Force Base, Guam National Wildlife Refuge, War in the Pacific National Historical Park, Guam, Rota and Saipan, CNMI, 2004–2005: U.S. Geological Survey Open-File Report 2005–1299.

Hoffmann, W. A., Schroeder, W. & Jackson, R. B. (2003). Regional feedbacks among fire, climate, and tropical deforestation. *Journal of Geophysical Research -Atmospheres, 108*(23).

Janeke, D. (2006). *Nocturnal movements and habitat use by the flying fox, Pteropus mariannus mariannus, on Guam.* (Master's Thesis) University of Guam.

Jenkins, J. M. (1983). The native forest birds of Guam. *Ornithological Monographs, 31*, 1-61.

Kerr, A.M. (2013). The partulid tree snails (Partulidae: Stylommatophora) of the Mariana Islands, Micronesia. University of Guam Marine Laboratory Technical Report 152. May 2013.

Kershner, E. L., Kohley, R. & Garcelon, D.K. (2007). Assessment of Mariana swiftlet diet and insect availability on Saipan and Rota, Mariana Islands. Unpublished report. Institute for Wildlife Studies, Arcata, California (www.iws.org).

Kessler, C. C. & Amidon, F. A. (2009). Micronesian Megapode on Tinian and Aguiguan U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office (Ed.), *Terrestrial Surveys of Tinian and Aguiguan, Mariana Islands, 2008 (Working Draft)*. Honolulu, Hawaii. Prepared for MARFORPAC and NAVFACPAC.

Larkin, R. P., Pater, L. L. & Tazik, D. J. (1996). Effects of military noise on wildlife: A literature review (pp. 1-107).

Lawrence, J. B. (2006, December 15). Mariana eight-spot butterfly observation, Andersen AFB, Guam, personal communication via telephone. T. Houston, Parsons Corporation, Austin, Texas.

Lodge, D. M., Williams, S., MacIsaac, H., Hayes, K., Leung, B., Loope, L., & McMichael, A. (2006). Biological invasions: recommendations for policy and management (Position Paper for the Ecological Society of America). *Ecological Applications, 16*, 2034-2054.

Lusk, M. R., Bruner, P. & Kessler, C. (2000, Winter). The Avifauna of Farallon De Medinilla, Mariana Islands. *Journal of Field Ornithology, 71*(1), 22-33.

Marshall, J. T. (1949). The endemic avifauna of Saipan, Tinian, Guam, and Palau. *Condor, 51*(220-221).

Michael, G.A. (1987). Notes on the breeding biology and ecology of the Mariana or Guam crow. *Aviculture Magazine 93:*73–82.

Morton, J. (1996). The effects of aircraft overflights on endangered Mariana crows and Mariana fruit bats at Andersen Air Force Base, Guam. Prepared for Department of the Navy, Pacific Division, Naval Facilities Engineering Command.

Morton, J. M. & Wiles, G. J. (2002). Observations of Mariana fruit bats (*Pteropus mariannus*) in the upper Talofofo watershed on southern Guam. *Micronesica, 34*, 155-163.

Mosher, S. M. & Fancy, S. G. (2002). Description of nests, eggs, and nestlings of the endangered Nightingale Reed-Warbler on Saipan, Micronesia. *Wilson Bulletin, 114*, 1-10.

Mueller-Dombois, D. & Fosberg, F. R. (1998). Vegetation of the tropical Pacific islands. New York: Springer-Verlag.

Navy Safety Center. (2009). BASH Hazard Data Summaries. Retrieved from http://www.safetycenter.navy.mil, 29 February 2012.

Neary, D. G., Ryan, K. C. & DeBano, L. F. (2005). Wildland fire in ecosystems: effects of fire on soils and water. (General Technical Report RMRS-GTR-42, Vol. 4). Ogden, Utah. Prepared for U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station.

O'Daniel, D. & Kreuger, S. (1999). Recent sightings of the Micronesian Megapode on Tinian, Mariana Islands. *Micronesica, 31*, 301-307.

Pierson, E. D., Elmqvist, T., Rainey, W. E. & Cox, P. A. (1996). Effects of cyclonic storms on flying fox populations on the south Pacific islands of Samoa. *Conservation Biology, 10*, 438-451.

Plentovich, S., Morton, J.M., Bart, J., Camp, R.J., Lusk, M., Johnson, N., & Vanderwerf, E. (2005). Population trends of Mariana Crow Corvus kubaryi on Rota, Commonwealth of the Northern Mariana Islands. *Bird Conservation International 15*: 211-224.

Pregill, G.K. & D. W. Steadman. (2009). The prehistory and biogeography of terrestrial vertebrates on Guam, Mariana Islands. *Diversity and Distributions* 15: 983–996.

Raulerson, L. & Rinehart, A. (1991). Trees and Shrubs of the Northern Mariana Islands. Guam: Self Published.

Raulerson, L. & Rinehart, A. (1997). Three species from Rota. University of Guam Herbarium Contribution No. 34, University of Guam, Territory of Guam. 18 pages.

Rodda, G. H., Fritts, T. H. & Chiszar, D. (1997, October). The Disappearance of Guam's Wildlife. *BioScience, 47*(9), 565-574.

Scheiner, I. H. & Nafus, D. M. (1996). Survey of rare butterflies in the Mariana Islands. Preliminary report to U.S. Fish and Wildlife Service. 10 pp.

Steadman, D. W. (1999). The prehistory of vertebrates, especially birds, on Tinian, Aguiguan, and Rota, Northern Mariana Islands. *Micronesica, 31*, 319–345.

Stinson, D. W., Ritter, M.W. & Reichel, J. D. (1991). The Mariana Common Moorhen: decline of an island endemic. *Condor 93*: 38–43.

Stone, B. C. (1970). The flora of Guam: A manual for the identification of the vascular plants of the island. *Micronesica, 6*, 1-659.

Stone, l. S. & Rubel, E. W. (2000). Cellular studies of auditory hair cell regeneration in birds. *Proceedings of the National Academy of Sciences of the United States of America, 97*(22), 714-721.

SWCA Environmental Consultants. (2009). The Effects of Flight Operations of Endangered Mariana Fruit Bats and Mariana Crows: A Monitoring Program for Andersen AFB, Guam. Prepared for 36th Civil Engineer Squadron Environmental Flight Unit 14007 Andersen Air Force Base, Guam and Air Force Center for Engineering and the Environment Brooks City-Base, Texas.

SWCA Environmental Consultants. (2012). Summary Report: Noise Study and Demographic Survey of Mariana Fruit Bats and Mariana Crows: Andersen Air Force Base Guam.

Takano, L. L. & Haig, S. M. (2004). Distribution and abundance of the Mariana subspecies of the Common Moorhen. *Waterbirds, 27*, 245–250.

Thompson, K. & Davis, M. (2011). Why research on traits of invasive plants tells us very little. *Trends in Ecology and Evolution, 26*, 155-156.

Tomback, D. F. (1986). Observations on the behavior and ecology of the Mariana crow. *Condor, 88*, 398-401.

Tunison, T., D'Antonio, C. M. & Loh, R. K. (2001). Fire and invasive plants in Hawaii Volcanoes National Park K. E. M. G. a. T. P. Wilson (Ed.), *Proceedings of the Invasive Species Workshop: The role of fire in the control and spread of invasive species*. Presented at the Fire Conderence 2000, The First National Congress on Fire Ecology, Prevention, and Management, Tall Timbers Research Station; Tallahassee, TN.

U.S. Air Force. (2008). Draft Base-wide Vegetation Survey, Mapping, and Report at Anderson AFB, Guam. Prepared by e2m for Andersen AFB 36 CES Environmental Flight and Air Force Center for Environmnetal Excellence, Hickam AFB, Hawaii. Contract number: F41624-03-D-8599, Task Order 0081.

U.S. Department of Defense. (2004). Department of Defense Ammunition and Explosives Safety Standards. DoD 6055.9-STD. Prepared by the Under Secretary of Defense for Acquisition, Technology, and Logistics. Washington, D.C.

U.S. Department of Defense. (2011). DTR 4500.9-R-Part V - Chapter 505 Agricultural Cleaning and Inspection Requirements. Washington, D.C.: United States Transportation Command.

U.S. Department of Defense. (2012). Bird/Animal Aircraft Strike Hazard. Department of Defense – Partners in Flight. Retrieved from http://dodpif.org/groups/bash.php, January 18, 2012.

U.S. Department of the Navy. (2008a). Fiscal Years 2007 and 2008 Report for 61755NR410 Wildlife Surveys on Military Leased Lands, Tinian CNMI. (pp. 13). Prepared by S. Vogt.

U.S. Department of the Navy. (2008b). Mariana Fruit Bat Surveys on Navy Properties, Guam, 2008. Prepared by A. Brooke. Prepared for NAVFACMAR.

U.S. Department of the Navy. (2008c). Micronesian Megapode (Megapodius laperouse laperouse) Surveys on Farallon de Medinilla, Commonwealth of the Northern Marianas Islands. (pp. 9).

U.S. Department of the Navy. (2008d). Micronesian Megapode (Megapodius laperouse laperouse) Surveys on Tinian, Commonwealth of the Northern Mariana Islands. (pp. 13). Prepared by S. Vogt.

U.S. Department of the Navy. (2009). Biological assessment for the Mariana Islands Range Complex terrestrial species consultation. Prepared by SRS-Parsons Joint Venture. Prepared for NAVFACPAC, Pearl Harbor, Hawaii.

U.S. Department of the Navy. (2010). Mariana Islands Range Complex Final Environmental Impact Statement, / Overseas Environmental Impact Statement. Prepared for Commander, Naval Facilities Engineering Command Pacific. Joint Base Pearl Harbor Hickam, Hawaii.

U.S. Department of the Navy. (2011). Marianas Training Manual (JTREGMARIANAS Instruction 3500.4A). April.

U.S. Department of the Navy. (2013a). 2013 Joint Region Marianas Integrated Natural Resources Management Plan.Draft Final (pp. 121). Prepared by HDR Contract # SF1449-N40192-10-R-9915. Prepared for Joint Region Marianas.

U.S. Department of the Navy. (2013b). Draft Annual Report: Wildlife Surveys on Tinian and FDM. Prepared by Joint Region Marianas.

U.S. Fish and Wildlife Service. (1990). Native Forest Birds of Guam and Rota of the Commonwealth of the Mariana Islands Recovery Plan. Portland, Oregon: U.S. Fish and Widlife Service, Region 1 (Pacific Region Office).

U.S. Fish and Wildlife Service. (1991). Recovery Plan for the Mariana Islands Population of the Vanikoro Swiftlet (*Aerodramus vanikorensis bartschi*) Final. Portland, Oregon: U.S. Fish and Wildlife Service, Region 1 (Pacific Region Office).

U.S. Fish and Wildlife Service. (1994). Recovery Plan for the *Serianthes nelsonii*. Honolulu, Hawaii: U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlfie Office.

U.S. Fish and Wildlife Service. (1998). Recovery Plan for the Micronesian Megapode (*Megapodius laperouse laperouse*). Portland, Oregon: U.S. Fish and Wildlife Service, Region 1 (Pacific Region Office).

U.S. Fish and Wildlife Service. (2006a). Biological opinion on the establishment and operation of an intelligence, surveillance, reconnaissance, and strike capability project on Andersen Air Force Base, Guam. (Consultation # 2006-F-0266). Honolulu, Hawaii: U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office.

U.S. Fish and Wildlife Service. (2006b). Draft Revised Recovery Plan for the Aga or Mariana Crow (*Corvus kubaryi*). Portland, Oregon: U.S. Fish and Widlife Service, Region 1 (Pacific Regional Office).

U.S. Fish and Wildlife Service. (2006c). U.S. Fish and Wildlife Service. 2007. Recovery Plan for Two Plants from Rota (*Nesogenes rotensis* and *Osmoxylon mariannense*).Portland, Oregon. 86 pp.

U.S. Fish and Wildlife Service. (2008a). *Birds of Conservation Concern 2008*. (pp. 85). Arlington, VA: U. S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management. Available from http://www.fws.gov/migratorybirds/

U.S. Fish and Wildlife Service. (2008b). Final Revised Recovery Plan for the Sihek or Guam Micronesian Kingfisher (*Halcyon cinnamomina cinnamomina*). Portland, Oregon: U.S. Fish and Wildlife Service, Region 1 (Pacific Region Office).

U.S. Fish and Wildlife Service. (2008c). Species Assessment and Listing Priority Assignment Form: Fragile Tree Snail (*Samoana fragilis*). Portland, Oregon: U.S. Fish and Wildlife Service, Region 1 (Pacific Region).

U.S. Fish and Wildlife Service. (2008d). Species Assessment and Listing Priority Assignment Form: Guam Tree Snail (*Partula radiolata*).

U.S. Fish and Wildlife Service. (2008e). Species Assessment and Listing Priority Assignment Form: Mariana Eight Spot Butterfly (*Hypolimnas octocula mariannensis*): U.S. Fish and Wildlife Service, Region 1 (Pacific Region).

U.S. Fish and Wildlife Service. (2009a). Aga or Mariana Crow (*Corvus kubaryi*) 5-Year Review Summary and Evaluation. Portland, Oregon: U.S. Fish and Wildlife Service, Region 1 (Pacific Region Office).

U.S. Fish and Wildlife Service. (2009b). Mariana Common Moorhen (*Gallinula chloropus guami*), 5-Year Review, Summary and Evaluation. Honolulu, Hawaii: U.S. Fish and Wildlife Services, Pacific Islands Fish and Wildlife Office.

U.S. Fish and Wildlife Service. (2009c). Draft Revised Recovery Plan for the Mariana Fruit Bat or Fanihi (*Pteropus mariannus mariannus*). U.S. Fish and Wildlife Service, Portland, Oregon. xiv + 83 pp.

U.S. Fish and Wildlife Service. (2009d). Terrestrial Resource Surveys of Tinian and Aguiguan. Prepared by the U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office. Honolulu, Hawaii.

U.S. Fish and Wildlife Service. (2010a). Biological Opinion for the Mariana Islands Range Complex, Guam and the Commonwealth of the Northern Mariana Islands 2010-2015. (Consultation # 2009-F-0345). Honolulu, Hawaii: USFWS Pacific Islands Fish and Wildlife Office.

U.S. Fish and Wildlife Service. (2010b). Nightingale reed-warbler five-year review. Honolulu, Hawaii: USFWS Pacific Islands Fish and Wildlife Office.

U.S. Fish and Wildlife Service. (2012). Candidate Notice of Review. Endangered and Threatened Wildlife and Plants; Review of Native Species That Are Candidates for Listing as Endangered or Threatened; Annual Notice of Findings on Resubmitted Petitions; Annual Description of Progress on Listing Actions. Docket No. FWS–R9–ES–2012–0050; MO–4500030113

U.S. Fish and Wildlife Service & National Marine Fisheries Service. (1998). Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. Washington D.C.

United States of America & Commonwealth of the Northern Mariana Islands. (1983). Lease agreement made pursuant to the covenant to establish a commonwealth of the Northern Mariana Islands in a political union with the United States of America.

Utzurrum, R. C. B., Wiles, G. J., Brooke, A. P., & Worthington, D.J. (2003). Count Methods and Population Trends in Pacific Island Flying Foxes T. e. a. O'Shea (Ed.), *Monitoring Trends in Bat Populations of the United States and Territories: Problems and Prospects. Information and Technology Report* (USGS/BRD/ITR-2003-0003).

Valdez, E. W., G. J. Wiles, & T. J. O'Shea. (2011). Diets of the Sympatric Pacific Sheath-Tailed Bat (Emballonura semicaudata rotensis) and Mariana Swiftlet (Aerodramus bartschi) on Aguiguan, Mariana Islands. *Pacific Science,* 65(3): 301-309.

VanderWerf, E. Y. (2000). Final Report. A Study to Determine the Effects of Noise from Military Training on the Endangered O'ahu 'Elepaio. Honolulu, Hawaii. Prepared by a. W. C.-P. Ebisu and Associates, Inc.

Vardon, M. & Tidemann, C. (2000). The black flying-fox (*Pteropus alecto*) in north Australia: juvenile mortality and longevity. *Australian Journal of Zoology, 48*, 91-97.

Vogt, S.R. & Williams, L.L. (2004). *Common Flora and Fauna of the Mariana Islands*. Self published, Commonwealth of the Northern Mariana Islands, 158 pp.

Wiewel, A. S., Adams, A. A. Y. & Rodda, G. H. (2009). Distribution, Density, and Biomass of Introduced Small Mammals in the Southern Mariana Islands. *Pacific Science, 63*(2), 205-222.

Wiles, G. J. (1998). Check List of Terrestrial Veterbrates and Selected Terrestrial Invertebrates of Guam. (pp. 8) Guam Department of Agriculture Division of Aquatic and Wildlife Resources.

Wiles, G. J., Lemke, T. O. & Payne, N. H. (1989). Population estimates of fruit bats (*Pteropus mariannus*) in the Mariana Islands. *Conservation Biology 3*, 66–76.

Wiles, G.J. (1990). Natural history, biology, and habitat protection for Marianas fruit bats. Pp. 136-144 In Division of Aquatic and Wildlife Resources annual report, fiscal year 1990 Ed by R.D. Andersen, G.W. Davis, L.L. Mariano, T.J. Pitlik and G.J. Wiles. Guam Division of Aquatic and Wildlife Resources. Mangilao, Guam, USA.

Wiles, G. J. & Woodside, D. H. (1999). History and population status of Guam swiftlets on Oahu, Hawaii. *Elepaio, 59*(7), 57-61.

Worthington, D.J. (1998). Inter-island dispersal of the Mariana common moorhen: a recolonization by an endangered species. *Wilson Bulletin 110*:414-417.

3.11 Cultural Resources

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

This Page Intentionally Left Blank

3.11 CULTURAL RESOURCES

CULTURAL RESOURCES SYNOPSIS

The United States Department of the Navy considered all potential stressors, and the following were analyzed for impacts on cultural resources.

- Acoustic (underwater explosives)
- Physical disturbance (ground disturbance, use of towed in-water devices, deposition of military expended materials, and use of seafloor devices)

Preferred Alternative (Alternative 1)

- Acoustic and Physical Disturbance: Acoustic and physical stressors, as indicated above, would not adversely affect submerged historic resources within United States territorial waters and National Register of Historic Places-eligible resources on Guam and the Commonwealth of the Northern Mariana Islands in accordance with Section 106 of the National Historic Preservation Act because measures were previously implemented to protect these resources and will continue to be implemented according to the conservation measures and procedures identified and described in the 2009 Mariana Islands Range Complex Programmatic Agreement. In accordance with Section 402 of National Historic Preservation Act, no World Heritage Sites would be affected.

3.11.1 INTRODUCTION

Cultural resources are found throughout the Mariana Islands Training and Testing (MITT) Study Area (Study Area). The approach for the assessment of cultural resources includes defining the resource; presenting the regulatory requirements for the identification, evaluation, and treatment within established jurisdictional parameters; establishing the specific resources subtypes in the Study Area; identifying the data used to define the current conditions; and providing the method for impact analysis (Section 3.0, Introduction).

Cultural resources are defined as any district, landscape, site, structure, or object, as well as other physical evidence of human activity, that are considered important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. Cultural resources include archaeological resources, historical architectural resources, and traditional cultural properties related to pre-contact (prior to European contact) and post-contact or historic periods.

Archaeological resources include pre-contact and post-contact locations or sites where human actions resulted in detectable changes. Archaeological resources can have a surface component, a subsurface component, or both. Archaeological resources also include human remains. Post-contact archaeological resources are those resources dating from after European contact. They may include subsurface features such as wells, cisterns, or privies. Other historical archaeological resources include artifact concentrations and building remnants (e.g., foundations). Submerged cultural resources include historic shipwrecks and other submerged historic materials, such as sunken airplanes and pre-contact cultural remains. Architectural resources are elements of the built environment. These resources include existing buildings; dams; bridges; and other structures of historic, engineering, or artistic significance. Factors in determining a resource’s significance are its age, integrity, design, and association with important events or persons. Traditional cultural resources are resources associated with beliefs and cultural practices of a living culture, subculture, or community. These beliefs and practices must be rooted in the group's history and must be important in maintaining the cultural identity of the group. Pre-contact archaeological sites and artifacts, historic and contemporary locations of traditional events, sacred places, landscapes, and resource collection areas, including fishing, hunting or gathering areas, may be traditional cultural resources.

Cultural resources are officially known as historic properties when they meet the specific criteria of the National Historic Preservation Act and its associated regulations. The cultural resources discussed in this section are historic properties unless otherwise noted (e.g., sovereign resources).

3.11.1.1 Identification, Evaluation, and Treatment of Cultural Resources

Procedures for the identification, evaluation, and treatment of cultural resources within United States (U.S.) territorial waters (within 12 nautical miles [nm]) are contained in a series of federal laws and regulations. Cultural resources are protected by a variety of laws and their implementing regulations: the National Historic Preservation Act of 1966 as amended in 2006; the Archeological and Historic Preservation Act of 1974; the Archaeological Resources Protection Act of 1979; the American Indian Religious Freedom Act of 1978; the Native American Graves Protection and Repatriation Act of 1990; the Submerged Lands Act of 1953; the Abandoned Shipwreck Act of 1987; and the Sunken Military Craft Act of 2004. The Advisory Council on Historic Preservation further guides treatment of archaeological and architectural resources through the regulations, *Protection of Historic Properties* (36 Code of Federal Regulations [C.F.R.] 800). Historic properties, as defined by the National Historic Preservation Act, represent the subset of cultural resources listed on, or eligible for, inclusion on the National Register of Historic Places. Historic properties, as defined by the National Historic Preservation Act, represent the subset of cultural resources listed in, or eligible for, inclusion in the National Register of Historic Places.

National Historic Landmarks are cultural resources of national historical importance and are automatically listed on the National Register of Historic Places. Under the implementing regulations for Section 106 of the National Historic Preservation Act (36 C.F.R. Part 800.10) and in accordance with the Secretary of the Interior's Standards and Guidelines for Federal Agency Historic Preservation Programs Pursuant to the National Historic Preservation Act (63 Federal Register 24 April 1998) (Section 110 Guidelines), special consideration to minimize harm to National Historic Landmarks is required, special emphasis on the public interest in the National Historic Landmarks and the proposed undertaking should be considered, and both the Advisory Council on Historic Preservation and the Secretary of the Interior are consulted if any adverse effects are likely to occur to such resources.

Section 106 of the National Historic Preservation Act requires federal agencies to consider the effects of their actions on historic properties which are defined as cultural resources listed in or eligible for inclusion in the National Register of Historic Places. The regulations implementing Section 106 (36 C.F.R. Part 800) specify a consultation process to assist in satisfying this requirement. Consultation with the appropriate State Historic Preservation Offices, the Advisory Council on Historic Preservation, individuals and organizations with a demonstrated interest in the undertaking, and state and federal agencies as required by Section 106 of the National Historic Preservation Act will be accomplished as part of the National Environmental Policy Act (NEPA) process for this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) for the portion of the Proposed Action within U.S. territorial waters (within 12 nm).

Additional regulations and guidelines for submerged historic resources include 10 U.S. Code (U.S.C.) 113, Title XIV for the Sunken Military Craft Act; the Abandoned Shipwreck Guidelines prepared by the

National Park Service (National Park Service 2007); and the Guidelines for Archaeological Research Permit Applications on Ship and Aircraft Wrecks under the Jurisdiction of the U.S. Department of the Navy (Navy) (36 C.F.R. 4, Part 767) overseen by the Naval History and Heritage Command. The Sunken Military Craft Act does not apply to actions taken by, or at the direction of, the United States. In accordance with the Abandoned Shipwreck Act, abandoned shipwrecks in state waters are considered the property of the U.S. Government (Barnette 2010). Warships or other vessels used for military purposes at the time of their sinking retain sovereign immunity (e.g., Japanese freighters). According to the principle of sovereign immunity, foreign warships sunk in U.S. territorial waters are protected by the U.S. Government, which acts as custodian of the sites in the best interest of the sovereign nation (Neyland 2001). In addition, the federal archaeological program, developed by the National Park Service by Presidential Order, includes a collection of historical and archaeological resource protection laws to which federal managers adhere.

The addendum to the National Historic Preservation Act (16 U.S.C. 470a-2: International Federal activities affecting historic properties) requires an assessment by federal agencies of project effects to resources located outside U.S. territorial waters that are identified on the World Heritage List. The Rock Island Southern Lagoon in Palau, inscribed on the World Heritage List in 2012, is located within the Study Area. The Rock Island Southern Lagoon consists of numerous large and small forested limestone islands, scattered within a marine lagoon protected by a barrier reef. The marine site covers 100,200 hectares and is characterized by coral reefs and a diversity of other marine habitats, as well as 445 coralline limestone islands. The Rock Island Southern Lagoon represents an extremely high habitat complexity, including the highest concentration of marine lakes in the world, which continue to yield discoveries of new species. The terrestrial environment also supports numerous endemic and endangered species. Although presently uninhabited, the islands were once home to Palauan settlements, and Palauans continue to use the area and its resources for cultural and recreational purposes. The islands contain a significant set of cultural remains relating to an occupation that lasted approximately 5,000 years and ended in abandonment (United Nations Educational, Scientific, and Cultural Organization 2012). Even though the Rock Island Southern Lagoon World Heritage Site occurs within the Study Area, it is within the territorial waters of Palau, and no proposed activities would occur in this area.

No specific procedures for the identification and protection of cultural resources within the open ocean have been defined by the international community (Zander and Varmer 1996). No treaty offering comprehensive protection of submerged cultural resources has been developed and implemented; however, a few international conventions prepared by the United Nations Educational, Scientific, and Cultural Organization are applicable to submerged cultural resources including the 1970 Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property, the 1972 Convention Concerning the Protection of the World Cultural and Natural Heritage, the 1982 Convention on the Law of the Sea, and the 2001 Convention on the Protection of the Underwater Cultural Heritage. Only the 1970 and 1972 conventions have been fully ratified by the United States.

3.11.1.2 Methods

3.11.1.2.1 Approach

The approach for establishing current conditions is based on different regulatory parameters defined by geographical location. Within 12 nm of the U.S. coastline (defined as U.S. territorial waters), the National Historic Preservation Act and NEPA are the guiding mandates.

Under the NEPA, an EIS/OEIS must consider the adverse and beneficial effects of a proposed federal action on historical and cultural resources (40 C.F.R. §1508.8). Under the implementing regulations of Section 106 of the National Historic Preservation Act, federal agencies must take into account the effects that an action would have on cultural resources listed in, or eligible for inclusion in, the National Register of Historic Places. As mentioned previously, the term “historic properties” is synonymous with National Register of Historic Places-eligible or listed archaeological, architectural, or traditional resources. Cultural resources not formally evaluated may also be considered potentially eligible (i.e., a Consensus Determination in consultation with the State Historic Preservation Office) and, as such, are afforded the same regulatory consideration as those resources listed on the National Register of Historic Places. Evaluations and determinations of historic properties within the Study Area is the responsibility of the federal agency in consultation with the Historic Preservation Offices.

Historic properties are defined in the National Historic Preservation Act (16 U.S.C. §470w(5)) as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in the National Register, including artifacts, records, and material remains related to such a property or resource. Properties are evaluated for nomination to the National Register of Historic Places and for evaluating eligibility of resources using the following criteria (36 C.F.R. §60.4[a]–[d]):

- Criterion A – Be associated with events that have made a significant contribution to the broad patterns of American history
- Criterion B – Be associated with the lives of persons significant in the American past
- Criterion C – Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction
- Criterion D – Yield, or may be likely to yield, information important in prehistory or history

A historic property also must possess several of the seven aspects of integrity (location, design, setting, materials, workmanship, feeling, and association) to convey its significance and qualify it for the National Register of Historic Places. To retain integrity, a property will always possess several, and usually most, of these aspects.

The following are defined as cultural resources within U.S. territorial waters:

- Resources listed on or eligible for listing on the National Register of Historic Places (Section 106 of the National Historic Preservation Act)
- Resources entitled to sovereign immunity (e.g., Japanese transport ships or *marus*)

3.11.1.2.2 Data Sources

Cultural resources information was obtained from Naval Facilities Engineering Command Pacific/Marianas cultural resources personnel; the National Register of Historic Places (National Register Information System); Guam Register of Historic Places; and the Commonwealth of Northern Mariana Islands (CNMI) listings for National Register of Historic Places-listed or eligible resources on Rota, Saipan, and Tinian. Primary summary information on cultural resources was derived from a variety of management plans, archaeological and architectural survey reports, archaeological testing reports, cultural landscape studies, and traditional cultural properties reports.

The online National Register Information System was reviewed to identify National Register of Historic Places-listed resources, historic districts, and National Historic Landmarks. Appropriate information from the Historic Preservation Offices was obtained and online databases reviewed for information on the location of submerged resources, type, and eligibility for listing in National Register of Historic Places.

3.11.1.2.3 Cultural Context

The chronology, or historical sequence for the Mariana Islands, is detailed in the Integrated Cultural Resource Management Plan for Guam (U.S. Department of the Navy 2005b) and Tinian (U.S. Department of the Navy 2003), as well as in the cultural resources synthesis for Guam (U.S. Department of the Navy 2005a) and *The Archaeology of Micronesia* (Rainbird 2004).

The pre-Latte Period (1500 B.C.–A.D. 1000) consists of the Early, Middle, and Late Unai phases and the Huyong phase. The Early Unai phase (1500–900 B.C.) is characterized by the highly decorated Lapita pottery which represents the earliest evidence of occupation in the Mariana Islands (Rainbird 2004). The Early Unai phase sites are located on the sandy beaches along the coastlines on Tinian and Saipan. The Middle Unai phase (900–400 B.C.) is characterized by a simpler bold-line decoration on the ceramics. Middle Unai phase sites are located at several sandy and rocky beaches, coastal rock shelters, and a few inland caves in the islands of Guam, Rota, Tinian, and Saipan. The Late Unai phase (400 B.C.–A.D. 400) is characterized by large thick-walled shallow pan-like ceramic vessels. Late Unai sites occur throughout coastal and inland areas of Guam, Rota, Tinian, and Saipan and include both surface and subsurface scatters of artifacts and midden in diverse settings. The Huyong phase (A.D. 400–1000) exhibits a continuation of large flat-bottomed pans which declines in frequency as pots with rounded bases and slightly incurved rims become more common. Surface and subsurface scatters of pottery and midden have been reported in both coastal and inland settings of Guam, Rota, Tinian, and Saipan.

The *Latte* Period (A.D. 1000–1668) is characterized by *latte* which are quarried and shaped columns and capstones that once supported house structures. Nearly all of these columns and capstones were made from quarried limestone, but some (especially in the farthest northern islands) include basalt elements. *Latte* sets include paired rows of upright slab-like columns, arranged in rectangles. *Lusong* (grinding mortars in basalt or limestone) and *lummok* (stone pounders) are common during this time indicating an increased reliance of pounded food processing. Rice agriculture most likely occurred during this period as evidenced by the presence of rice impressions in ceramic pottery. The latter part of the *Latte* Period coincides with the early Spanish period. The early Spanish period refers to an extended period of Spanish contact with minimized direct impact on native Chamorro culture. This period begins with Magellan's arrival in the region in 1521, and it ends with the arrival of Spanish missionaries and soldiers intent on making radical changes and a long-term Spanish colony, in 1668.

In the Spanish Period (A.D. 1668–1898), the nature of contact between Chamorro and Spanish populations changed radically after the arrival of Father Diego Luis de Sanvitores and his party. The missionaries quickly began converting the Chamorro people to the Christian religion, also bringing many other social changes. The Spanish efforts that began in 1668 quickly led to conflict and violence, and the following few decades involved rapid and devastating impacts on the Chamorro people. Under Spanish influence, maize was introduced, and it soon became the staple food crop. Maize processing implements (*manos* and *metates*) replaced older food-pounders and mortars. Cattle, carabao (water buffalo), pigs, goats, and deer were also introduced and created new economic opportunities. In the early 1800s, the Manila galleons stopped their annual circuit across the Pacific, as the Spanish colonies in the Americas gained independence from Spain. The Philippines assumed Spanish administrative control of the Mariana Islands in 1817. Whaling ships were common at Guam between 1823 and 1853. During this time, approximately 30 ships provisioned at Guam each year. Between 1815 and 1820, canoe-loads of Carolinian Islander refugees requested permission from the Spanish governor to resettle in the Mariana Islands. In exchange for services rendered to the government, many of these refugees were allowed to settle in Saipan. In the 1880s, more Carolinian Islanders immigrated to the Mariana Islands. Carolinian communities were established throughout the islands.

The Pre-War Naval Administration (A.D. 1898–1941) on Guam and the Japanese Colonial/Pre-War Period for the Northern Mariana Islands reflects early United States, German, and then Japanese control of the northern Marianas. In June 1898, during the Spanish-American War, the U.S. cruiser *Charleston* arrived at Apra Harbor to take control of Guam from Spain. Spain ceded Guam to the United States in 1899, and the Navy was given responsibility for the administration of Guam. Under U.S. rule before 1941, Guam served as a fueling station for ships between the United States and Asia, the site of the trans-Pacific cable station, the base of a strategic Naval radio station, and a landing place for the Pan American trans-Pacific air clippers flying between San Francisco and Hong Kong.

As part of an agreement at the end of the Spanish-American War, Spain decided to dispose of all remaining colonies in the Pacific and sold the Mariana Islands north of Guam along with the Caroline Islands to Germany. The end of the Spanish-American War resulted in the political separation of the Mariana Islands and the islands' inhabitants that still continues today. These colonial and political decisions, except for the CNMI covenant, were not made by the inhabitants of the islands. The Germans were interested in developing an agricultural cash crop economy in the Northern Marianas, based on copra production. Vast coconut plantations were started, but two typhoons in 1905 devastated the young coconut trees. In October 1914, a Japanese naval squadron seized control of Saipan and other German possessions in Micronesia. Saipan was placed under military jurisdiction, and German nationals were expelled. In 1921, the League of Nations awarded the Mariana Islands, except Guam, officially to Japan.

The Japanese Mandated Islands included more than the Northern Mariana Islands. A separate treaty included the non-fortification provision (these islands would not be fortified for military use) which applied to both Japanese and U.S. occupations on Guam. In 1922, the Nan'yō Kōhatsu Kabushiki Kaisha/Nankō (NKK, the South Seas Development Company) was established in Saipan to develop large-scale sugarcane production. Extensive plantations and settlements were developed in Saipan, Tinian, Rota, and Aguijan, vastly transforming the landscapes of these islands. Smaller-scale Japanese land use occurred at the various smaller islands in the Northern Marianas.

The World War II (A.D. 1941–1945) period covers Japanese occupation and U.S. liberation of the Mariana Islands. On 8 December 1941, Japanese planes attacked Guam, a few hours after the attack at Pearl Harbor on the O'ahu Island of Hawai'i. The Navy administration in Guam had not engaged in any substantial military build-up, despite being surrounded by Japanese-controlled islands of the Japanese Mandate. After just two days, Japanese forces landed at Guam, and the Navy commander surrendered just two hours later. Throughout 1942 and 1943, Japanese Navy forces occupied Guam and brutalized the native population. Beginning in March 1944, with the increased threat of a U.S. military invasion, Japanese reinforcements landed at Guam. The Japanese Army assumed control of Guam and began to fortify the likely invasion landing beaches. The local population was forced to provide labor and eventually forced into internment camps. During just a few years, large-scale Japanese defensive constructions had greatly transformed sections of Guam and Saipan, and less extensive transformations occurred in Rota and Tinian. Camouflaged bunkers, carved tunnels, and various gun emplacements were numerous. The United States began its attack on Japanese-controlled Saipan on 15 June 1944, with air strikes that destroyed 150 Japanese planes. The U.S. Liberation of Guam commenced on 21 July 1944. From Saipan, U.S. forces began a bombardment of Tinian ending with a landing invasion on 24 July.

Guam, Saipan, and Tinian then served as the staging base for B-29 bombers (Twentieth Air Force) on missions to the Japanese mainland, including the atomic bombing of Hiroshima and Nagasaki that effectively ended World War II.

The U.S. Post-War (A.D. 1945–present) Period represents continued administration of the Mariana Islands by the United States. Guam was established as a U.S. flag territory and was governed separately under Navy administration. A civilian government was established in 1949, and Guam was made a U.S. territory in 1950. Still, the U.S. military presence has remained significant in Guam. Many of the World War II facilities continued to be used, and additional facilities were added in response to military needs associated with the Cold War, Korean War, and Vietnam War.

In 1947, a congressional resolution established the Trust Territory of the Pacific Islands and was signed into law by President Truman who then officially handed control over Micronesia to the Navy. The Northern Mariana Islands became part of the post-World War II United Nations' Trust Territory of the Pacific Islands. The United States became the administering authority under the terms of a trusteeship agreement (first under the Navy in 1947 and then under the Department of Interior in 1951). In 1976, Congress approved the mutually negotiated Covenant to Establish a CNMI in Political Union with the United States. The CNMI Government adopted its own constitution in 1977, and the constitutional government took office in January 1978.

3.11.1.3 Methods of Impact Analysis

Impact analysis for cultural resources is based on different parameters defined by geographical location. Within U.S. territorial waters, Section 106 of the National Historic Preservation Act and NEPA evaluation are the guiding mandates. In general, impacts are assessed by the importance of the resource; the sensitivity of the resource to proposed activities; and the duration of the effects on the environment (Section 3.0, Introduction).

3.11.2 Affected Environment

Several types of cultural resources are associated with the MITT Study Area: pre-contact (pre-A.D. 1521) archaeological sites, historic archaeological sites including submerged historic resources and man-made obstructions, historic architectural resources, and traditional cultural properties.

3.11.2.1 Guam

3.11.2.1.1 Cultural Resources Eligible for or Listed in the National Register of Historic Places

Over 540 cultural resources associated with Guam are considered eligible for or listed in the National Register of Historic Places including 8 individual resources listed in the National Historic of Historic Places, 6 listed on the Guam Register of Historic Places only but may most likely be considered eligible for the National Register of Historic Places as well, and 348 pre-contact sites, 36 multicomponent sites, 117 historic archaeological sites, 18 buildings, and 66 structures (Table 3.11-1).

Table 3.11-1: Cultural Resources Eligible for and Listed in the National Register of Historic Places, and National Historic Landmarks, Guam

Location	Resource	Description	Guam Register of Historic Places	National Register of Historic Places	Reference
Commercial Harbor	2 submerged historic resources	*SMS Cormoran*, German ship, World War I	Listed	Listed	Guam Register of Historic Places 2008; National Register Information System 2008a
		Tokai Maru, Japanese passenger-cargo freighter, World War II	Listed	Listed	Guam Register of Historic Places 2008; National Register Information System 2008
Naval Base Guam Polaris Point, Naval Base Guam Apra Harbor, Delta/Echo Fuel Piers, Sasa Valley Tank Farm, Tenjo Vista Tank Farm	3 historic sites	Cable Station Remains	Listed	Listed	Guam Register of Historic Places 2008; National Register Information System 2008a
		Japanese Midget Submarine	Listed	Likely eligible	Guam Register of Historic Places 2008; National Register Information System 2008a
		Sumay Cemetery	Listed	Likely eligible	Guam Register of Historic Places 2008

Table 3.11-1: Cultural Resources Eligible for and Listed in the National Register of Historic Places, and National Historic Landmarks, Guam (continued)

Location	Resource	Description	Guam Register of Historic Places	National Register of Historic Places	Reference
Naval Base Guam Polaris Point, Naval Base Guam Apra Harbor, Delta/Echo Fuel Piers, Sasa Valley Tank Farm, Tenjo Vista Tank Farm	Pre-contact rock shelter and petroglyphs, historic fort, steps, and well complex	Orote Historical Complex	Listed	Listed	Guam Register of Historic Places 2008; National Register Information System 2008a; Athens 2009
	16 pre-contact sites and 9 multicomponent sites	Middle and Late Unai occupations; Huyong occupations; *Latte* period sites; Late *Latte* period villages		Eligible	U.S. Department of the Navy 2005b; Athens 2009
	55 historic archaeological sites	Spanish period site Fort San Luis; Pre-War Naval Administration period Cable Station Superintendent's Building; Japanese trenches, foxholes, pillboxes, heavy caliber weapons, and Camp Bright		Eligible	U.S. Department of the Navy 2005b; Dixon et al. 2011

Table 3.11-1: Cultural Resources Eligible for and Listed in the National Register of Historic Places, and National Historic Landmarks, Guam (continued)

Location	Resource	Description	Guam Register of Historic Places	National Register of Historic Places	Reference
Naval Base Guam Polaris Point, Naval Base Guam Apra Harbor, Delta/Echo Fuel Piers, Sasa Valley Tank Farm, Tenjo Vista Tank Farm	13 buildings and 23 structures	Administration, shop, and office buildings, fallout shelter, sheds, floating dry docks, piers, breakwater, wharves, beach fortifications, Japanese bunkers, seaplane ramp, bridge, and reservoir		Eligible	U.S. Department of the Navy 2005b; Mason Architects, Inc. and Weitze Research 2010
Navy Base Guam Munitions Site	2 cave and rock shelter complexes	Middle Unai Phase, Pre-*Latte* and *Latte* Periods	Listed	Likely eligible	Guam Register of Historic Places 2008; National Register Information System 2008a
	Latte Period deposits; World War II massacre of Chamorro by the Japanese	Fena Massacre Site	Listed	Likely eligible	Guam Register of Historic Places 2008
	263 pre-contact sites; 27 multicomponent sites	Middle Unai, Late Unai, Huyong, and *Latte* Period sites		Eligible	U.S. Department of the Navy 2005b

Table 3.11-1: Cultural Resources Eligible for and Listed in the National Register of Historic Places, and National Historic Landmarks, Guam (continued)

Location	Resource	Description	Guam Register of Historic Places	National Register of Historic Places	Reference
Navy Base Guam Munitions Site	46 historic archaeological sites	Airplane crash location, a baseball field, water supply features, depressions, concrete blocks, Japanese fortifications, and artifact scatters		Eligible	U.S. Department of the Navy 2005b
	5 buildings; 39 structures	ARMCO buildings, abandoned magazines, storehouses, revetments, reservoirs, and bridges		Eligible	U.S. Department of the Navy 2005b
Naval Base Guam Telecommunications Site	2 pre-contact sites	Late Unai and *Latte* Period sites	Listed	Listed	Guam Register of Historic Places 2008; National Register Information System 2008a; U.S. Department of the Navy 2005a
	21 pre-contact sites	Middle Unai, Late Unai, Huyong, *Latte* Period sites		Eligible	U.S. Department of the Navy 2005a

Table 3.11-1: Cultural Resources Eligible for and Listed in the National Register of Historic Places, and National Historic Landmarks, Guam (continued)

Location	Resource	Description	Guam Register of Historic Places	National Register of Historic Places	Reference
Naval Base Guam Telecommunications Site	1 historic archaeological site	Cave used by Navy radioman to evade capture during World War II		Eligible	U.S. Department of the Navy 2005a
Naval Base Guam Barrigada	2 historic archaeological sites	Barrigada Battlefield and Well, and Officers Country		Eligible	U.S. Department of the Navy 2005b
Andersen Air Force Base	World War II airfield	Northwest Field		Listed	U.S. Air Force 2011
	Cold War era airfield	North Field		Eligible	National Park Service (2012)
	Pati Point Complex	Chamorro village with caves, stone structures, possible *latte* stones, and dense midden deposits	Listed	Likely eligible	U.S. Air Force 2011
	Tarague Beach Historic District	139 archaeological localities including rock alignments, artifact scatters, rock shelters, rock mounds, bedrock mortars, and trails	Listed	Likely eligible	April 2006; U.S. Air Force 2011
	48 pre-contact sites	Including the Lafac site		Eligible	U.S. Air Force 2011; Athens 2009; Dixon and Walker 2011; Griffin et al. 2011

Table 3.11-1: Cultural Resources Eligible for and Listed in the National Register of Historic Places, and National Historic Landmarks, Guam (continued)

Location	Resource	Description	Guam Register of Historic Places	National Register of Historic Places	Reference
	14 historic archaeological sites	Spanish oven and well, a stone pier, a farmhouse, water catchment features, Japanese defensive sites, and traditional farms		Eligible	U.S. Air Force 2011; Dixon and Walker 2011
	3 historic structures	Two reservoirs and a well		Eligible	U.S Air Force 2004

Notes: ARMCO = American Rolling Mill Company, U.S.= United States

A total of 13 possible traditional cultural properties have been identified on Guam installations, including six archaeological sites, another six nonarchaeological (natural features) sites, and one property bearing both archaeological and non-archaeological characteristics, all associated with the Chamorro. Three traditional cultural properties are listed on the National Register of Historic Places as archaeological sites: Haputo Beach, Latte Stone Park, and Sumay Cemetery (Griffin et al. 2010a).

3.11.2.1.2 Known Wrecks, Obstructions, or Occurrences (within the United States Territorial Waters)

Previous archival research and literature reviews conducted to identify submerged resources around Guam indicate at least 84 submerged historic resources, including 63 documented shipwrecks dating between 1520 and 1941 (Carrell et al. 1991). However, only the locations of about 60 known wrecks, obstructions, or occurrences (e.g., shipwrecks, aircraft, and military equipment) have been determined (Figure 3.11-1), including one World War II-era amphibious tractor in Agat Bay and 31 submerged wrecks, obstructions, or occurrences in the Guam Commercial Harbor (work and fishing boats; barges; tugs; landing craft utility vessels; a British passenger ship ("C S Scotia"); WWII Japanese freighters or transport ships ("Tokai Maru," "Kitsugawa Maru," and "Nichiyu Maru"); and three Japanese planes from World War II commonly referred to as Val, Jake, and Hufe) (Carrell et al. 1991; Lotz 1998). Additional offshore resources include amphibious tractor treads, American landing vehicles tracked, World War II debris and ordnance fields, a Japanese Zero (airplane), and the "Aratama Maru" (Carrell et al. 1991; Lotz 1998). Most obstructions are usually found to be modern debris.

3.11.2.1.3 World Heritage Sites

The World Heritage List was reviewed, and no World Heritage sites are located in or around Guam.

3.11.2.1.4 Resources with Sovereign Immunity

As a result of World War I and, particularly, World War II, ships were bombed or torpedoed and sunk within 12 nm miles of Guam. The German ship, "SMS Cormoran" (PacificWreck.com 2011) and several Japanese freighters, the "Tokai Maru," "Kitsugawa Maru," "Nichiyu Maru," and the "Aratama Maru" retain sovereign immunity.

3.11.2.2 Commonwealth of Northern Mariana Islands

3.11.2.2.1 Farallon de Medinilla

A preliminary archaeological field survey of Farallon de Medinilla (FDM) was conducted in 1996 (Welch 2010). No archaeological sites or isolated non-modern artifacts were observed. Only modern debris associated with the military use of the island was observed.

3.11.2.2.2 Tinian

3.11.2.2.2.1 Cultural Resources Eligible for or Listed in the National Register of Historic Places

Over 340 cultural resources associated with Tinian are considered eligible for or listed in the National Register of Historic Places including 1 National Historic Landmark, 1 individually listed resource (the Unai Dankulo Petroglyph site), 90 pre-contact sites, and 257 historic archaeological sites (Table 3.11-2).

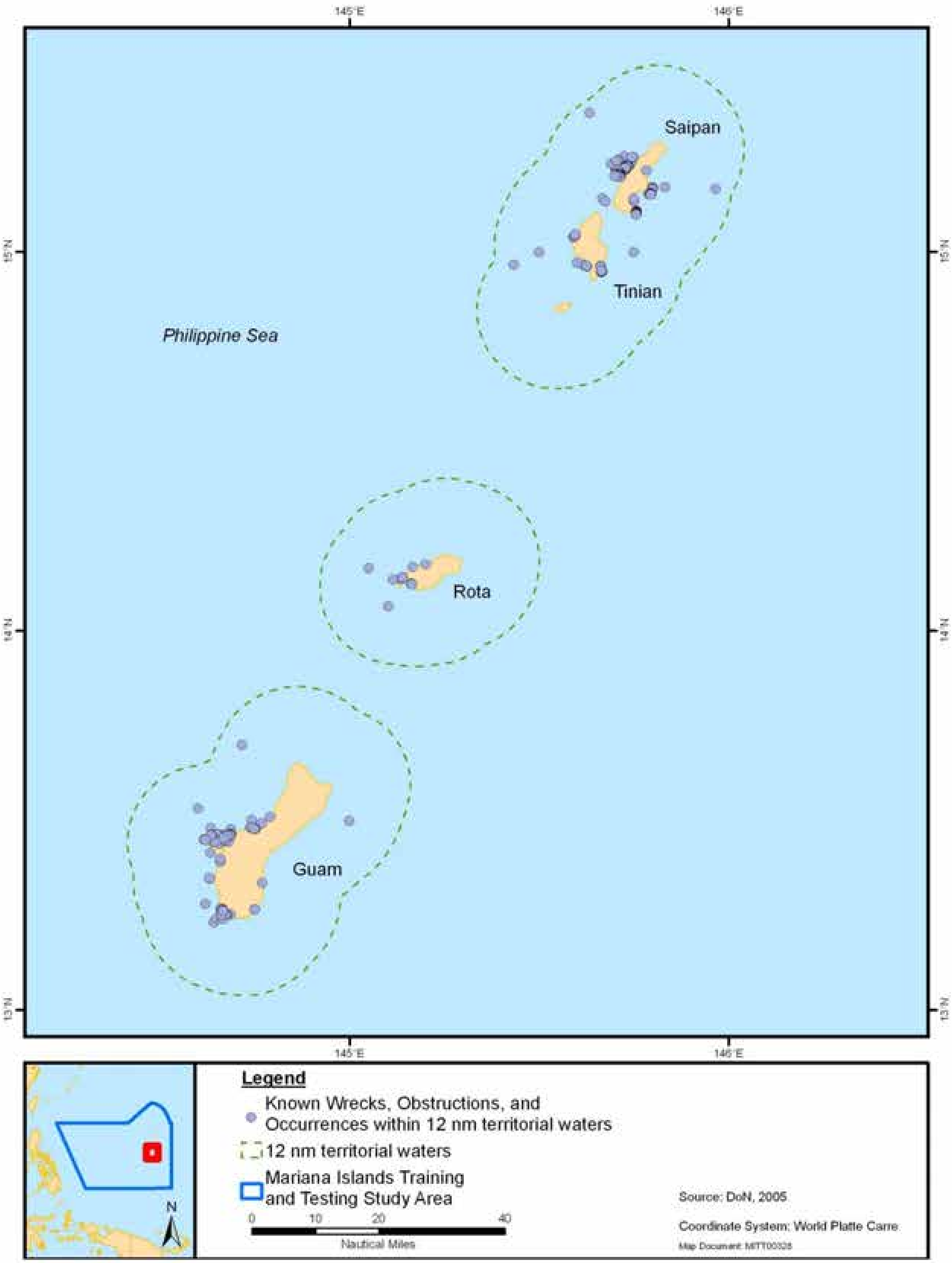


Figure 3.11-1: Known Wrecks, Obstructions, or Occurrences within the United States Territorial Waters

Table 3.11-2: Cultural Resources Eligible for and Listed in the National Register of Historic Places, and National Historic Landmarks, Tinian

Resource	Description	CNMI Register of Historic Places	National Register of Historic Places	National Historic Landmark/ Monument	Reference
Tinian Landing Beaches, Ushi Point Field, and North Field	Landing beaches White 1 and White 2 (Unai Babui and Unai Chulu) and landing craft and craft fragments; the Japanese pillbox at Beach White 2; the Japanese service apron, air administration building, air operations building, and two air raid shelters at former Ushi Point Field; and a complex of runways, aprons and parking areas at North Field	Listed	Listed	Listed	Commonwealth of the Northern Mariana Islands 2008; National Register Information System 2008b; U.S. Department of the Navy 2003; U.S. Department of the Navy 2010
Unai Dankulo Petroglyph Site	Unai Dankulo Petroglyph Site	Listed	Eligible		Commonwealth of the Northern Mariana Islands 2008; National Register Information System 2008b
90 pre-contact sites	Middle Unai, Late Unai, Huyong, *Latte* Period sites		Eligible		Rainbird 2004; U.S. Department of the Navy 2003
257 historic sites	Japanese civilian or colonial, post-war Chamorro, and U.S. occupations		Eligible		U.S Department of the Navy 2003

Note: CNMI = Commonwealth of the Northern Mariana Islands, U.S.= United States

A total of 13 possible traditional cultural properties have been identified on Tinian and all are archaeological sites; nine are associated with the Chamorro and four are associated with the Japanese (Griffin et al. 2010b).

3.11.2.2.2.2 Known Wrecks, Obstructions, or Occurrences (within the United States Territorial Waters)

Previous archival research and literature reviews conducted to identify submerged resources around Tinian indicate at least 19 submerged historic resources (Carrell et al. 1991). However, only the locations of nine known wrecks, obstructions, or occurrences have been determined, including the "Mitakesan Maru" and the "Seizan Maru" (see Figure 3.11-1). Most obstructions are usually found to be modern debris.

3.11.2.2.2.3 World Heritage Sites

The World Heritage List was reviewed, and no World Heritage sites are located in or around Tinian.

3.11.2.2.2.4 Resources with Sovereign Immunity

As a result of World War II, ships were bombed or torpedoed and sunk within 12 nm of Tinian. Japanese freighters, the "Mitakesan Maru" and the "Seizan Maru," retain sovereign immunity.

3.11.2.2.3 Saipan

The Saipan Army Reserve Center was constructed in 2006 (Donato 2006). The building is not considered a historic architectural resource. Leased pier space on Saipan consists of approximately 100 acres (40.5 hectares) in the Wharf area. This area is highly developed and it is likely that any previously existing cultural resources have been disturbed or destroyed. No intact cultural resources are likely to occur. The east side of north Saipan is used by the Army Reserves who conduct land navigation training on non-Department of Defense land.

3.11.2.2.3.1 Known Wrecks, Obstructions, or Occurrences (within the United States Territorial Waters)

Previous archival research and literature reviews conducted to identify submerged resources around Saipan indicate at least 51 submerged historic resources (Carrell et al. 1991). However, only the locations of 36 known wrecks, obstructions, or occurrences have been determined, including the "Keiyo Maru," the "Taian Maru," a floating boat, a float plane, a harbor dredge, tanks, Japanese landing barges, American landing vehicles tracked, World War II debris fields, and railroad cars (Carrell et al. 1991; Lotz 1998) (see Figure 3.11-1). Most obstructions are usually found to be modern debris.

3.11.2.2.3.2 World Heritage Sites

The World Heritage List was reviewed, and no World Heritage sites are located in or around Saipan.

3.11.2.2.3.3 Resources with Sovereign Immunity

As a result of World War II, ships were bombed or torpedoed and sunk within 12 nm of Saipan. Two Japanese freighters, the "Keiyo Maru" and the "Taian Maru," retain sovereign immunity.

3.11.2.2.4 Rota

Leased pier space on Rota includes the use of Angyuta Island seaward of Song Song's West Harbor as a Forward Staging Base/overnight bivouac site. The island is adjacent to the commercial port facility that is used for boat refueling and maintenance. No historic properties were identified during a visual field inspection of Angyuta Island in February 2009.

3.11.2.2.4.1 Known Wrecks, Obstructions, or Occurrences (within the United States Territorial Waters)

Previous archival research and literature reviews conducted to identify submerged resources around Rota indicate at least 12 submerged historic resources (Carrell et al. 1991). However, only the locations of seven known wrecks, obstructions, or occurrences were determined (see Figure 3.11-1), including the "Shotoku Maru," the "Shoun Maru," and Japanese submarine chasers 54 and 56 (Carrell et al. 1991; Lotz 1998). Most obstructions are usually found to be modern debris.

3.11.2.2.4.2 World Heritage Sites

The World Heritage List was reviewed, and no World Heritage sites are located in or around Rota.

3.11.2.2.4.3 Resources with Sovereign Immunity

As a result of World War II, ships were bombed or torpedoed and sunk within 12 nm of Rota. Japanese freighters, the "Shotoku Maru," the "Shoun Maru," and Japanese submarine chasers 54 and 56 retain sovereign immunity.

3.11.2.3 Mariana Islands Training and Testing Transit Corridor

The length and variable width of the MITT transit corridor is such a vast area that it precludes systematic survey for submerged historic resources. In addition, waters along the MITT transit corridor are deep, sometimes over 18,000 feet (ft.) (5,486 meters [m]); as a consequence, identification of submerged historic resources on the sea floor at these depths is prohibitive. However, in accordance with the addendum to the National Historic Preservation Act (16 U.S.C. 470a-2) regarding international federal activities affecting historic properties, the World Heritage List was reviewed, and no cultural resources on the list were identified within the MITT transit corridor.

3.11.2.4 Current Requirements, Practices, and Protective Measures

3.11.2.4.1 Avoidance of Obstructions

The Navy routinely avoids locations of known obstructions which include submerged cultural resources such as historic shipwrecks. Known obstructions are avoided to prevent damage to sensitive Navy equipment and vessels, and to ensure the accuracy of training and testing exercises.

3.11.2.4.2 Mariana Islands Range Complex Programmatic Agreement

A Programmatic Agreement was negotiated for all military training activities proposed under the Preferred Alternative for the Mariana Islands Range Complex (MIRC) based on consultations with the Guam State Historic Preservation Office, CNMI Historic Preservation Office, Advisory Council on Historic Preservation, and the National Park Service. The training constraints map identifies 13 No Training areas (eight on Guam and five on Tinian) and 35 Limited Training areas (20 on Guam and 15 on Tinian), refined from the previous Military Operations Area constraints map boundaries (U.S. Department of Defense 2009). Limited Training areas are defined as pedestrian traffic areas with vehicular access limited to designated roadways and/or the use of rubber-tired vehicles. No pyrotechnics, demolition, or digging is allowed without prior consultation with the appropriate Historic Preservation Office. In addition to establishing No Training and Limited Training areas, stipulations for additional cultural resources investigations in unsurveyed areas; archaeological monitoring and conditions documentation of military use of ingress and egress paths and training areas; and preparation of field reports were also implemented.

3.11.2.4.3 Guam and Commonwealth of the Northern Mariana Islands Military Relocation Programmatic Agreement

A Programmatic Agreement was executed on 14 March 2011 for all undertakings, such as establishing new training areas, base housing, and office areas; maintenance, rehabilitation, repair, construction and demolition of buildings, structures, and roads; and installing, repairing, and updating utilities and infrastructure on Guam and the CNMI, associated with the Joint Guam and CNMI Build Up project (U.S. Department of Defense 2011). The Programmatic Agreement provides stipulations for the identification and evaluation of historic properties through cultural resources field investigations; project review based on probability of occurrence and type of effects to cultural resources (i.e., No Effect, Potential Effect, No Adverse Effect, and Adverse Effect); preparation and implementation of work plans and data recovery; and other mitigation measures including updating existing preservation plans, public interpretation of specific resources, preparation of general documents for public dissemination, preparation of a cultural landscape report, curation of archaeological collections and documentation; and access to traditional cultural properties for indigenous peoples and organizations.

3.11.3 Environmental Consequences

This section presents the analysis of potential impacts on cultural resources from implementation of the project alternatives, including the No Action Alternative, Alternative 1, and Alternative 2. As stated in Section 3.11.1.2.1 (Approach), NEPA and Section 106 of the National Historic Preservation Act are the guiding mandates and apply to U.S. territorial waters (within 12 nm). In accordance with an addendum to the National Historic Preservation Act, only potential impacts to World Heritage sites will be addressed in areas beyond 12 nm.

The stressors vary in intensity, frequency, duration, and location within the Study Area. Some activities, such as sinking exercises, would occur at locations greater than 50 nm from shore. The stressors applicable to cultural resources in the study area and analyzed below include the following:

- Acoustic (underwater explosives)
- Physical disturbance and strike (ground disturbance, use of towed in-water devices, deposition of military expended materials, and use of seafloor devices)

The specific analysis of the training and testing activities presented in this section considers the relevant components and associated data within the geographic location of the activity (see Tables 2.8-1 and 2.8-4) and the resource.

The use of sonar does not affect the structural elements of historic shipwrecks; therefore, no further analysis is required for cultural resources in this document. Archaeologists use multi-beam sonar and side-scan sonar as a regular practice in effectively exploring shipwrecks without disturbance. Based on the physics of underwater sound, the shipwreck would need to be very close (less than 22 ft. [7 m]) to the sonar sound source for the shipwreck to potentially experience any slight oscillations from the induced pressure waves. Any oscillations experienced at less than 22 ft. (7 m) would be negligible up to less than a few yards from the sonar source. This distance is smaller than the typical safe navigation and operating depth for most sonar sources and therefore is not expected to impact historic shipwrecks.

Office of Naval Research testing activities proposed at the North Pacific Acoustic Laboratory involve the use of an acoustic tomography array, a distributed vertical line array, and moorings deployed in the deep-water environment of the northwestern Philippine Sea. These acoustic experiments use non-explosive acoustic sources; therefore, these activities do not generate shock (pressure) waves from underwater explosions or create cratering on the seafloor that could impact submerged historic resources. Although some acoustic experiments employ in-water devices, these types of activities are conducted in areas where the sea floor is deeper than the length of the tow lines, and vessel and in-water device strikes on submerged historic resources on the seafloor would not occur. No military expended materials are created from the acoustic experiments. Because the Navy routinely avoids locations of known obstructions, which include submerged historic resources, it is unlikely that these resources were disturbed by the deployment of moorings associated with the existing use of the North Pacific Acoustic Laboratory. The acoustic experiments proposed by the Office of Naval Research at the North Pacific Acoustic Laboratory would not affect submerged historic resources or World Heritage Sites; therefore, no further analysis of cultural resources is required in this document for activities at this location.

3.11.3.1 Acoustic Stressors

Acoustic stressors that have the potential to impact cultural resources are shock (pressure) waves and vibrations from underwater explosions and cratering created by underwater explosions. A shock wave and oscillating bubble pulses resulting from any kind of underwater explosion, such as explosive torpedoes, missiles, bombs, projectiles, airguns, and mines could impact the exposed portions of submerged historic resources if such resources were located in the vicinity. Shock (pressure) waves generated from underwater explosions would be episodic rather than continuous and could create overall structural instability and eventual collapse of architectural features of submerged historic resources. The amount of damage would depend on factors such as size of the charge, distance from the historic shipwreck, water depth, and topography of the seafloor.

3.11.3.1.1 Impacts from Explosives – Shock (Pressure) Waves from Underwater Explosions

Explosions associated with bombs, missiles, and projectiles occur at or immediately below the ocean surface (within 1 m [3.3 ft.]). In addition, some explosions associated with torpedoes and certain mine warfare activities may occur deeper in the water column. These types of explosions are within the water column and shock (pressure) waves would not reach submerged historic resources on the seafloor. Underwater detonations of explosives from other mine warfare activities would occur near or on the seafloor. Shock (pressure) waves have the potential to damage architectural features of submerged historic resources if such resources are located in the vicinity.

3.11.3.1.1.1 No Action Alternative

Training Activities

Under the No Action Alternative, current training activities and the level of activity would remain the same and would continue within existing designated areas within the MITT Study Area. Current training activities would continue to be conducted in accordance with existing Section 106 compliance documents: the *Programmatic Agreement for the MIRC* (U.S. Department of Defense 2009) to protect National Register of Historic Places-listed or eligible cultural resources.

In addition to the military training agreement documents, recorded cultural resources would continue to be managed in accordance with procedures identified in the *Updated Cultural Resources Management Plan for the Tinian Military Lease Area (MLA)* (U.S. Department of the Navy 2003), the *Regional Integrated Cultural Resources Management Plan for COMNAVREG Marianas Lands, Volume I: Guam* (U.S. Department of the Navy 2005b), and the *Integrated Cultural Resources Management Plan for Andersen Air Force Base, Guam, 2008 Update* (U.S. Air Force 2011).

Testing Activities

Under the No Action Alternative, no testing activities creating shock waves from underwater explosions with a potential to affect submerged historic resources would occur.

3.11.3.1.1.2 Alternative 1

Training Activities

Under Alternative 1, Limpet Mine Neutralization System/Shock Wave Generator activities and associated explosive rounds would increase from no activities under the No Action Alternative to 40 activities in the MITT Study Area. Training activities using high explosives would not typically occur within approximately 3 nm from shore, while lower net explosive weight (NEW) explosives (up to 20 pounds [lb.] NEW) would occur at underwater detonation sites within Apra Harbor (Apra Harbor Underwater Detonation Site) and Agat Bay Floating Mine Neutralization Site. At Piti Point Floating Mine

Neutralization Site, the maximum NEW would remain the same as with the No Action Alternative (a maximum allowable threshold of 10 lb. NEW). As with the No Action Alternative, 20 activities involving explosive detonations within Agat Bay and Apra Harbor are proposed under Alternative 1. For activities that occur in nearshore environments and further from shore, the Navy routinely avoids locations of known obstructions which include submerged historic resources. It is unlikely that these resources could be disturbed or destroyed from shock waves created by underwater explosions used during mine warfare activities or other training activities that use explosives. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no training activities would occur at that location.

Testing Activities

Under Alternative 1, torpedo testing activities and associated explosive munitions would increase from no activities under the No Action Alternative to 2 activities and mine countermeasure mission package testing activities would increase from no activities in the No Action Alternative to 32 activities within the MITT Study Area. These activities would be conducted greater than 3 nm from shore. The Navy routinely avoids locations of known obstructions which include submerged historic resources. It is unlikely that these resources could be disturbed or destroyed from shock waves created by underwater explosions used during torpedo testing and mine countermeasure mission package testing activities. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no testing activities would occur at that location.

3.11.3.1.1.3 Alternative 2

Training Activities

Under Alternative 2, Limpet Mine Neutralization System/Shock Wave Generator activities and associated explosive rounds would increase from no activities under the No Action Alternative to 40 activities in the MITT Study Area, the same as Alternative 1. Explosive charges at mine neutralization sites, Agat Bay Floating Mine Neutralization Site and Apra Harbor Underwater Detonation Site, would increase from 10 lb. to 20 lb. NEW. Because the Navy routinely avoids locations of known obstructions which include submerged historic resources, it is unlikely that these resources could be disturbed or destroyed from shock waves created by underwater explosions during mine warfare activities.

Testing Activities

Under Alternative 2, torpedo testing activities and associated explosive munitions would increase from no activities in the No Action Alternative to 2 activities and mine countermeasure mission package testing activities would increase from no activities in the No Action Alternative to 36 activities within the MITT Study Area. These activities would be conducted greater than 3 nm from shore. The Navy routinely avoids locations of known obstructions which include submerged historic resources. It is unlikely that these resources could be disturbed or destroyed from shock waves created by underwater explosions used during torpedo testing and mine countermeasure mission package testing activities. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no testing activities would occur at that location.

3.11.3.1.2 Impacts from Explosives – Cratering

Underwater explosions near or on the sea floor could create sediment displacement in the form of cratering and could affect submerged historic resources at or near the explosive impact. Cratering of unconsolidated soft bottom habitats would result from charges set on or near the bottom. For a specific explosive charge size, crater depths and widths would vary depending on depth of the charge and sediment type. However, crater dimensions generally decrease as bottom depth increases. Cratering could disrupt the horizontal patterning and vertical stratigraphy of submerged historic resources, and could subsequently destroy those characteristics that would make them eligible for listing on the National Register of Historic Places. It is unlikely that these resources could be disturbed or destroyed from cratering created by underwater explosions during mine warfare activities because the Navy routinely avoids locations of known obstructions that include submerged historic resources.

3.11.3.1.2.1 No Action Alternative

Training Activities

Under the No Action Alternative, current mine warfare training activities and the level of activity would remain the same and would continue within existing designated areas within the MITT Study Area. Current training activities would continue to be conducted in accordance with existing Section 106 compliance documents: the *Programmatic Agreement for MIRC* (U.S. Department of Defense 2009) to protect National Register of Historic Places-listed or eligible cultural resources.

In addition to the military training agreement documents, recorded cultural resources would continue to be managed in accordance with procedures identified in the *Updated Cultural Resources Management Plan for the Tinian Military Lease Area (MLA)* (U.S. Department of the Navy 2003), the *Regional Integrated Cultural Resources Management Plan for COMNAVREG Marianas Lands, Volume I: Guam* (U.S. Department of the Navy 2005a), and the *Integrated Cultural Resources Management Plan for Andersen Air Force Base, Guam, 2008 Update* (U.S. Air Force 2011).

Testing Activities

Under the No Action Alternative, no testing activities creating cratering of the seafloor by deep underwater explosions with a potential to affect submerged historic resources would occur.

3.11.3.1.2.2 Alternative 1

Training Activities

Under Alternative 1, Mine Neutralization Remotely Operated Vehicle Sonar activities and associated explosive rounds with cratering created by deep underwater explosions would increase from no activities under the No Action Alternative to 4 activities in the MITT Study Area. Explosive charges at mine neutralization sites, Agat Bay Floating Mine Neutralization Site and Apra Harbor Underwater Detonation Site, would increase from 10 lb. to 20 lb. NEW. Because the Navy routinely avoids locations of known obstructions which include submerged historic resources, it is unlikely that these resources could be disturbed or destroyed from cratering created by deep underwater explosions.

Testing Activities

Under Alternative 1, testing activities that employ explosive munitions would increase from no activities under the No Action Alternative to 2 activities within the MITT Study Area. These activities would be conducted greater than 3 nm from shore. The Navy routinely avoids locations of known obstructions which include submerged historic resources. It is unlikely that these resources could be disturbed or destroyed from shock waves created by underwater explosions used during torpedo testing activities. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no testing activities would occur at that location.

3.11.3.1.2.3 Alternative 2

Training Activities

Under Alternative 2, Mine Neutralization Remotely Operated Vehicle Sonar activities and associated explosive rounds with cratering created by deep underwater explosions would increase from no activities under the No Action Alternative to 4 activities, the same impact as Alternative 1. Explosive charges at mine neutralization sites, Agat Bay Floating Mine Neutralization Site and Apra Harbor Underwater Detonation Site, would increase from 10 lb. to 20 lb. NEW. Because the Navy routinely avoids locations of known obstructions which include submerged historic resources, it is unlikely that these resources could be disturbed or destroyed from cratering created by deep underwater explosions. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no training activities would occur at that location.

Testing Activities

Under Alternative 2, testing activities that employ explosive munitions would increase from no activities under the No Action Alternative to 2 activities within the MITT Study Area. These activities would be conducted greater than 3 nm from shore. The Navy routinely avoids locations of known obstructions which include submerged historic resources. It is unlikely that these resources could be disturbed or destroyed from shock waves created by underwater explosions used during torpedo testing activities. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no testing activities would occur at that location.

3.11.3.1.3 Regulatory Conclusions of Acoustic Stressors

Acoustic stressors resulting from underwater explosions creating shock (pressure) waves or cratering of the seafloor during training or testing activities would not adversely affect submerged historic resources within U.S. territorial waters because the Navy routinely avoids known submerged obstructions. In accordance with Section 402 of National Historic Preservation Act, no World Heritage Sites would be affected.

3.11.3.2 Physical Disturbance and Strike Stressors

Any physical disturbance of the ground surface such as construction or training activities with tracked vehicles, cratering and soil displacement from high explosive strikes, increased pedestrian access, and physical disturbance on the sea floor, such as targets or mines resting on the ocean floor, moored mines, bottom-mounted tripods and low-flying unmanned underwater vehicles could inadvertently damage or destroy submerged historic resources if such resources are located within the MITT Study Area. Expended materials, such as chaff, flares, projectiles, casings, target fragments, missile fragments, non-explosive practice munitions, munitions fragments, rocket fragments, ballast weights, sonobuoys, torpedo launcher accessories, and mine shapes can be deposited on the ocean bottom on or in the vicinity of submerged historic resources. Heavier expended materials have the potential to damage intact fragile shipwreck features if they land on this resource type with velocity. However, it is unlikely these resources could be disturbed or destroyed because the Navy routinely avoids locations of known obstructions that include submerged historic resources.

3.11.3.2.1 Impacts from Ground Disturbance

Physical disturbance to archaeological sites may occur through tracked vehicle use during training and testing activities, cratering and soil displacement from high explosive strikes, and disturbance or removal of archaeological materials from temporary or permanent increased access to sites by military personnel. In accordance with existing Section 106 compliance documents, all known sites are avoided and mitigation measures are in place to prevent and reduce disturbance.

3.11.3.2.1.1 No Action Alternative

Training Activities

Under the No Action Alternative, current training activities and the level of activity would remain the same and would continue within existing designated areas within the MITT Study Area on Guam and the Commonwealth of the Northern Mariana Islands. Current training activities would continue to be conducted in accordance with existing Section 106 compliance documents: the Programmatic Agreement for MIRC (U.S. Department of Defense 2009) to protect National Register of Historic Places-listed or eligible cultural resources.

In addition to the military training agreement documents, cultural resources would continue to be managed in accordance with procedures identified in the *Updated Cultural Resources Management Plan for the Tinian Military Lease Area (MLA)* (U.S. Department of the Navy 2003), the *Regional Integrated Cultural Resources Management Plan for COMNAVREG Marianas Lands, Volume I: Guam* (U.S. Department of the Navy 2005a), and the *Integrated Cultural Resources Management Plan for Andersen Air Force Base, Guam, 2008 Update* (U.S. Air Force 2011).

Testing Activities

Under the No Action Alternative, no testing activities creating ground disturbance with a potential to affect cultural resources have been identified.

3.11.3.2.1.2 Alternative 1

Training Activities

Under Alternative 1, the number of training activities and the number of high explosive rounds, such as bombing exercises, would increase from the No Action Alternative and create ground disturbance (Table 3.0-22) provides a summary of ordnance use on FDM for each alternative). These activities, however, are located on FDM which contains no cultural resources. The number of training activities associated with Amphibious Raid-Special Purposed Marine Air Ground Task Force would increase on the Tinian Beaches; however, training activities would continue to follow established protocol for limited training areas and to avoid established off limit areas (no training permitted) (U.S. Department of Defense 2009); therefore, no National Register of Historic Places-eligible resources would be affected.

Testing Activities

Under Alternative 1, no testing activities creating ground disturbance with a potential to affect cultural resources have been identified.

3.11.3.2.1.3 Alternative 2

Training Activities

Under Alternative 2, the number of training activities and the number of high explosive rounds, such as Strike Warfare, would increase from the No Action Alternative and Alternative 1 and create ground disturbance; however, these activities are located on FDM which contains no cultural resources. The number of training activities associated with Amphibious Raid-Special Purposed Marine Air Ground Task Force would increase on the Tinian Beaches; however, training activities would continue to follow established protocol for limited training areas and to avoid established off limit areas (no training permitted) (U.S. Department of Defense 2009); therefore, no National Register of Historic Places-eligible resources would be affected.

Testing Activities

Under Alternative 2, no testing activities creating ground disturbance with a potential to affect cultural resources have been identified.

3.11.3.2.2 Impacts from Vessel and In-Water Device Strikes

In-water devices as discussed in this analysis are unmanned vehicles, such as remotely operated vehicles, unmanned surface vehicles and unmanned undersea vehicles, and towed devices. These devices are self-propelled and unmanned or towed through the water from a variety of platforms, including helicopters and surface ships. The use of towed systems would not affect submerged cultural resources because these types of activities are conducted in areas where the sea floor is deeper than the length of the tow lines. Prior to deploying a towed device, there is a standard operating procedure to search the intended path of the device for any floating debris (e.g., driftwood) or other potential surface obstructions, since they have the potential to cause damage to the device. The use of in-water devices would not impact submerged historic resources because these devices are designed and operated within the water column and they do not contact the seafloor.

3.11.3.2.2.1 No Action Alternative

Training Activities

Under the No Action Alternative, current training activities using in-water devices and the level of activity would remain the same and would continue within existing designated areas within the MITT Study Area. Current training activities would continue to be conducted in accordance with existing Section 106 compliance documents: the Programmatic Agreement for MIRC (U.S. Department of Defense 2009) to protect National Register of Historic Places-listed or eligible cultural resources.

In addition to the military training agreement documents, cultural resources would continue to be managed in accordance with procedures identified in the *Updated Cultural Resources Management Plan for the Tinian Military Lease Area (MLA)* (U.S. Department of the Navy 2003), the *Regional Integrated Cultural Resources Management Plan for COMNAVREG Marianas Lands, Volume I: Guam* (U.S. Department of the Navy 2005a), and the *Integrated Cultural Resources Management Plan for Andersen Air Force Base, Guam, 2008 Update* (U.S. Air Force 2011).

Testing Activities

Under the No Action Alternative, no testing activities using in-water devices with a potential to affect cultural resources have been identified.

3.11.3.2.2.2 Alternative 1

Training Activities

Under Alternative 1, the number of training activities using in-water devices would increase from 174 activities under the No Action Alternative to 1,175 activities in the MITT Study Area. The use of in-water devices would not impact submerged historic resources because these devices are designed and operated within the water column and they do not contact the seafloor. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no training activities would occur at that location.

Testing Activities

Under Alternative 1, the number of testing activities using in-water devices would increase from no activity under the No Action Alternative to 257 activities in the MITT Study Area. The use of in-water devices would not impact submerged historic resources because these devices are operated within the water column and they do not contact the seafloor. The Rock Island Southern Lagoon World Heritage Site is within the territorial waters of Palau, and no testing activities would occur at that location.

3.11.3.2.2.3 Alternative 2

Training Activities

Under Alternative 2, the number of training activities using in-water devices would increase from 174 activities under the No Action Alternative to 1,185 activities. Alternative 2 would increase training activities that use seafloor devices by 110 activities over Alternative 1. The use of in-water devices would not impact submerged historic resources because these devices are operated within the water column and they do not contact the seafloor. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no training activities would occur at that location.

Testing Activities

Under Alternative 2, the number of testing activities using in-water devices would increase from no activity under the No Action Alternative to 338 activities in the MITT Study Area. The increase proposed under Alternative 2 is 28 more activities than proposed under Alternative 1. As with Alternative 1, the use of in-water devices would not impact submerged historic resources because these devices are operated within the water column and they do not contact the seafloor. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no testing activities would occur at that location.

3.11.3.2.3 Impacts from Military Expended Materials

Deposition of non-explosive practice munitions, sonobuoys, and military expended materials other than ordnance may affect submerged cultural resources through possible sudden impact of resources on the seafloor or the simple settling of military expended materials on top of submerged cultural resources. These potential impacts are combined in this discussion.

The locations of over 140 known wrecks, obstructions, occurrences, or sites noted as “unknown” have been determined within U.S. territorial waters in the MITT Study Area. It is likely that the majority of these wrecks, obstructions, occurrences, or sites do not qualify as historic properties based on the results of previous underwater studies in the areas. Most anticipated expended munitions would be small objects and fragments that would slowly drift to the seafloor after striking the ocean surface. Larger and heavier objects such as non-explosive practice munitions could strike the ocean surface with velocity, but their trajectory would be slower as they move through the water.

If expended materials should sink in the vicinity of or on a submerged cultural resource, the expended materials would not affect the archaeological or historic characteristics of the submerged historic resource that contribute to its eligibility for the National Register of Historic Places or the World Heritage List. However, the likelihood of expended materials either impacting or landing on submerged historic resources is very low because the Navy routinely avoids known submerged obstructions.

3.11.3.2.3.1 No Action Alternative

Training Activities

Under the No Action Alternative, training activities would continue within existing designated areas in the MITT Study Area. Expended materials could be deposited on the seafloor on or in the vicinity of submerged historic resources. If they should sink in the vicinity of a cultural resource, the expended materials would not affect the archaeological or historic characteristics of the submerged historic resource. However, due to the size of the MITT Study Area and because the Navy routinely avoids known submerged obstructions, it is unlikely these materials would come into contact with a submerged historic resource.

<u>**Testing Activities**</u>

Under the No Action Alternative, no testing activities with the potential to expend military materials that could be deposited on the seafloor on or in the vicinity of submerged known historic resources have been identified.

3.11.3.2.3.2 Alternative 1

<u>**Training Activities**</u>

Under Alternative 1, the number of expended items from training activities would increase from the No Action Alternative. Expended materials could be deposited on the seafloor on or in the vicinity of submerged cultural resources if such resources occurred within the training areas and were not avoided. If they should sink in the vicinity of a cultural resource, the expended materials would not affect the archaeological or historic characteristics of the submerged historic resource. However, it is unlikely these materials would come into contact with a submerged historic resource since known resource locations are routinely avoided.

<u>**Testing Activities**</u>

Under Alternative 1, the number of expended items from testing activities would increase from the No Action Alternative. Expended materials could be deposited on the seafloor on or in the vicinity of submerged historic resources. If they should sink in the vicinity of this type of cultural resource, the expended materials would not affect the archaeological and historic characteristics of the submerged historic resource. However, it is unlikely these materials would come into contact with a submerged historic resource since known resource locations are routinely avoided.

3.11.3.2.3.3 Alternative 2

<u>**Training Activities**</u>

Under Alternative 2, the number of expended items from training activities would increase from the No Action Alternative and Alternative 1. Expended materials could be deposited on the seafloor on or in the vicinity of submerged historic resources. If they should sink in the vicinity of this type of cultural resource, the expended materials would not affect the archaeological or historic characteristics of the submerged historic resource. However, it is unlikely these materials would come into contact with a submerged historic resource since known resource locations are routinely avoided.

<u>**Testing Activities**</u>

Under Alternative 2, the number of expended items from testing activities would increase from the No Action Alternative and Alternative 1. Expended materials could be deposited on the seafloor on or in the vicinity of submerged historic resources. If they should sink in the vicinity of either this of cultural resource, the expended materials would not affect the archaeological and historic characteristics of the submerged historic resource. However, it is unlikely that these materials would come into contact with a submerged historic resource since known resource locations are routinely avoided.

3.11.3.2.4 Impacts from Seafloor Devices

Seafloor devices include moored mine shapes, anchors, and bottom-placed instruments. Seafloor devices are either stationary or move very slowly along the bottom. Stationary devices are specifically placed within the Study Area. Divers are used to set bottom and moored mine anchors (blocks of concrete weighing several hundred pounds) in water less than 150 ft. (45.7 m) deep and routinely avoid known obstructions, which include historic resources. Any physical disturbance on the continental shelf and seafloor could inadvertently damage or destroy submerged historic resources if such resources are located within the MITT Study Area and are not avoided. However, it is unlikely these resources could be disturbed by the use of seafloor devices because the Navy routinely avoids locations of known obstructions that include submerged historic resources.

3.11.3.2.4.1 No Action Alternative

Training Activities

Under the No Action Alternative, current mine warfare training activities using seafloor devices, such as moored mine shapes, would continue to be conducted within the MITT Study Area. Current training activities would continue to be conducted in accordance with existing Section 106 compliance documents: the *Programmatic Agreement for MIRC* (U.S. Department of Defense 2009) to protect National Register of Historic Places-listed or eligible cultural resources.

In addition to the military training agreement documents, recorded cultural resources would continue to be managed in accordance with procedures identified in the *Updated Cultural Resources Management Plan for the Tinian Military Lease Area (MLA)*, the *Regional Integrated Cultural Resources Management Plan for COMNAVREG Marianas Lands, Volume I: Guam* (U.S. Department of the Navy 2005a), and the *Integrated Cultural Resources Management Plan for Andersen Air Force Base, Guam, 2008 Update* (U.S. Air Force 2011).

Testing Activities

Under the No Action Alternative, current testing activities using seafloor devices, such as the North Pacific Acoustic Lab Philippine Sea 2018–19 Experiment, would continue and the level of activity would remain the same within the MITT Study Area.

3.11.3.2.4.2 Alternative 1

Training Activities

Under Alternative 1, mine warfare training activities using seafloor devices such as moored mine shapes would be conducted within the Mariana littorals and Inner and Outer Apra Harbor, representing an increase over the No Action Alternative. Because the Navy routinely avoids locations of known obstructions which include submerged historic resources, it is unlikely that these resources could be disturbed by the use of seafloor devices. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no training activities would occur at that location.

Testing Activities

Under Alternative 1, the number of testing activities using seafloor devices, such as mine countermeasure mission package testing activities, would increase from the No Action Alternative. Because the Navy routinely avoids locations of known obstructions which include submerged historic resources, it is unlikely that these resources could be disturbed by the use of seafloor devices. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no testing activities would occur at that location.

3.11.3.2.4.3 Alternative 2

Training Activities

Under Alternative 2, mine warfare training activities using seafloor devices such as moored mine shapes would be conducted within the Mariana littorals and Inner and Outer Apra Harbor, representing an increase over the No Action Alternative and would be the same as Alternative 1. Because the Navy routinely avoids locations of known obstructions which include submerged historic resources, it is unlikely that these resources could be disturbed by the use of seafloor devices. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no training activities would occur at that location.

Testing Activities

Under Alternative 2, the number of testing activities using seafloor devices, such as mine countermeasure mission package testing activities, would increase from the No Action Alternative and Alternative 1. Because the Navy routinely avoids locations of known obstructions which include submerged historic resources, it is unlikely that these resources could be disturbed by the use of seafloor devices. The Rock Island Southern Lagoon World Heritage Site is situated within the territorial waters of Palau, and no testing activities would occur at that location.

3.11.3.2.5 Regulatory Conclusions of Physical Disturbance and Strike Stressors

Physical stressors resulting from vessel strikes and use of in-water devices would not adversely affect submerged resources because these devices are operated within the water column and they do not contact the seafloor. The use of seafloor devices during training and testing activities under Alternative 1 and Alternative 2 would not adversely affect submerged historic resources because the Navy routinely avoids locations of known submerged obstructions and would continue to follow established protocol for limited training areas and to avoid established off limit areas (no training permitted) as defined in the 2009 Programmatic Agreement (U.S. Department of Defense 2009). Ground disturbance associated with existing training activities on Guam and the Commonwealth of the Northern Mariana Islands, and with increased amphibious training activities on Tinian would continue to follow established protocol for limited training areas and to avoid established off limit areas (no training permitted) as defined in the 2009 Programmatic Agreement (U.S. Department of Defense 2009); therefore, no National Register of Historic Places eligible resources would be adversely affected. In accordance with Section 402 of National Historic Preservation Act, no World Heritage Sites would be affected.

3.11.4 SUMMARY OF POTENTIAL IMPACTS ON CULTURAL RESOURCES

3.11.4.1 Combined Impact of All Stressors

3.11.4.1.1 No Action Alternative

Training activities associated with acoustic and physical stressors would not impact cultural resources because measures have been previously implemented to protect these resources and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement (U.S. Department of Defense 2009).

3.11.4.1.2 Alternative 1

Changes in the number and type of training and testing activities from the No Action Alternative would occur under Alternative 1. Training and testing activities associated with acoustic and physical stressors would not impact cultural resources because measures have been previously implemented to protect these resources and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement (U.S. Department of Defense 2009).

3.11.4.1.3 Alternative 2

Changes in the number and type of training and testing activities would occur under Alternative 2. Training and testing activities associated with acoustic and physical stressors would not impact cultural resources because measures have been previously implemented to protect these resources and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement (U.S. Department of Defense 2009).

3.11.4.2 Regulatory Determinations

Table 3.11-3 summarizes the potential effects of the Proposed Action on cultural resources. The MIRC Programmatic Agreement is in effect and satisfies the requirement for consultation as long as the stipulations in that Programmatic Agreement are followed.

Table 3.11-3: Summary of Section 106 Effects of Training and Testing Activities on Cultural Resources

Alternative and Stressor	Section 106 Effects of Training and Testing Activities
No Action Alternative	
Acoustic Stressors	Acoustic stressors resulting from underwater explosions creating shock (pressure) waves and cratering of the sea floor would not adversely affect submerged historic resources within U.S. territorial waters because measures have been previously implemented to protect these resources and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement.
Physical Disturbance and Strike Stressors	Physical disturbance and strike stressors including vessel strikes, use of towed in-water devices, use of seafloor devices, and ground disturbance during training and testing activities would not adversely affect submerged historic resources within U.S. territorial waters and National Register of Historic Places-eligible resources on Guam and the Commonwealth of the Northern Mariana Islands because measures have been previously implemented to protect these resources and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement.
Regulatory Determination	***No adverse effects would occur to submerged historic resources or National Register of Historic Places-eligible resources on Guam and the Commonwealth of the Northern Mariana Islands because measures have been previously implemented to protect these resources*** **and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement.**
Alternative 1	
Acoustic Stressors	Acoustic stressors resulting from underwater explosions creating shock (pressure) waves and cratering of the seafloor would not adversely affect submerged historic resources within U.S. territorial waters because measures have been previously implemented to protect these resources and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement.
Physical Disturbance and Strike Stressors	Physical disturbance and strike stressors including vessel strikes, use of towed in-water devices, use of seafloor devices, and ground disturbance during training and testing activities would not adversely affect submerged historic resources within U.S. territorial waters and National Register of Historic Places-eligible resources on Guam and the Commonwealth of the Northern Mariana Islands because measures have been previously implemented to protect these resources and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement.
Regulatory Determination	***Alternative 1 includes increases in the number of training and testing activities. Adverse effects would not occur to submerged historic resources within U.S. territorial waters and National Register of Historic Places-eligible resources on Guam and the Commonwealth of the Northern Mariana Islands because measures have been previously implemented to protect these resources*** **and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement.**

Table 3.11-3: Summary of Section 106 Effects of Training and Testing Activities on Cultural Resources (continued)

Alternative and Stressor	Section 106 Effects of Training and Testing Activities
Alternative 2	
Acoustic Stressors	Acoustic stressors resulting from underwater explosions creating shock (pressure) waves and cratering of the seafloor would not adversely affect submerged historic resources within U.S. territorial waters because measures have been previously implemented to protect these resources and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement.
Physical Disturbance and Strike Stressors	Physical disturbance and strike stressors including vessel strikes, towed in-water devices, use of seafloor devices, and ground disturbance during training and testing activities would not adversely affect submerged historic resources within U.S. territorial waters and National Register of Historic Places-eligible resources on Guam and the Commonwealth of the Northern Mariana Islands because measures have been previously implemented to protect these resources and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement.
Regulatory Determination	***Alternative 2 includes increases in the number of training and testing activities compared to the No Action Alternative. Adverse effects would not occur to submerged historic resources within U.S. territorial waters and National Register of Historic Places-eligible resources on Guam and the Commonwealth of the Northern Mariana Islands because measures have been previously implemented to protect these resources*** **and would continue to be implemented according to the conservation measures and procedures identified and described in the 2009 MIRC Programmatic Agreement.**

Notes: MIRC= Mariana Islands Range Complex, U.S.= United States

REFERENCES

April, V. (2006). Talagi Pictograph Cave. *Micronesian Journal of the Humanities and Social Sciences, 5*(1/2), 53-69.

Athens, J. S. (2009). Archaeological Surveys and Cultural Resources Studies on Guam and the Commonwealth of the Northern Mariana Islands in Support of the Joint Guam Build-Up Environmental Impact Statement. In D. o. t. Navy (Ed.) (Vol. Contract N62742-06-D-1870, Task Order 0007). Pearl Harbor, Hawaii: Naval Facilities Engineering Command, Pacific.

Barnette, M. C. (2010). Lost at sea: A treatise on the management and ownership of shipwrecks and shipwreck artifacts. Retrieved from http://uwex.us/lostatsea.htm, 2010, October 22.

Carrell, T., Boyer, D., Davi, R., Driver, M. G., Foster, K., Lenihan, D. J., . . . Rock, T. (1991). Micronesia Submerged Cultural Resources Assessment. Submerged Cultural Resources Unit, Southwest Cultural Resources Center, Southwest Region, National Park Service, U.S. Department of the Interior. Southwest Cultural Resources Center Professional Papers No. 36. Santa Fe, New Mexico.

Dixon, B. & Walker, S. (2011). Cultural Resources Investigations Conducted in the Territory of Guam Supporting the Joint Guam Build-up Environmental Impact Statement: Archaeological Surveys on Guam 2009 at Proposed Utility Site, Harmon Annex, and Andersen Air Force Base. In D. o. t. Navy (Ed.) (Vol. Contract N62742-06-D-1870, Task Order 0007). Pearl Harbor, Hawaii: Naval Facilities Engineering Command, Pacific.

Dixon, B., Walker, S. & Carson, M. (2011). Cultural Resources Investigations Conducted in the Territory of Guam Supporting the Joint Guam Build-up Environmental Impact Statement: Final Archaeological Surveys on Guam 2008-2009 at Air Force Barrigada, Proposed Live Fire Training Range, Andersen South, and Naval Base, Guam. In D. o. t. Navy (Ed.) (Vol. Contract N62742-06-D-1870, Task Order 0007). Pearl Harbor, Hawaii: Naval Facilities Engineering Command, Pacific.

Donato, A. E. (2006). Reserve Center Dedicated to Fallen Soldiers. Retrieved from www.saipantribune.com/newsstory.aspx?newsID+62519&cat=1, October 20, 2011.

Griffin, A. E., Carson, M. T. & Peterson, J. A. (2010a). Final: A Study of Potential Traditional Cultural Properties in Guam. Prepared by U. o. G. Micronesian Area Research Center, with TEC Inc. Joint Venture. Prepared for Department of the Navy, Naval Facilities Engineering Command, Pacific.

Griffin, A. E., Carson, M. T. & Peterson, J. A. (2010b). Final: A Study of Potential Traditional Cultural Properties in Tinian. Prepared by U. o. G. Micronesian Area Research Center, with TEC Inc. Joint Venture. Prepared for Department of the Navy, Naval Facilities Engineering Command, Pacific.

Lotz, D. (1998). World War II Remnants: Guam, Northern Mariana Islands, A Guide and History. Guam: Making Tracks.

Mason Architects Inc. & Weitze Research. (2010). Cold War HIstoric Context and Architectural Inventory for Naval Base Guam: Main Base, Piti Power Station, Drydock Island and Polaris Point. Prepared by Mason Architects and Weitze Research under contract to International Archaeological Research Institute. Prepared for Department of the Navy, Naval Facilities Engineering Command, Pacific and Commander Navy Region Marianas.

National Park Service. (2007). Abandoned Shipwreck Guidelines. Retrieved from http://www.nps.gov/archeology/submerged/intro.htm, August 8, 2007.

National Park Service. (2012). Historic American Engineering Record, Andersen Air Force Base, North Field. HAER No. Gu-9. U.S. Department of the Interior. San Francisco, California.

Neyland, R. S. (2001). Sovereign immunity and the management of United States naval shipwrecks and shipwreck artifacts. Retrieved from http://www.history.navy.mil/branches/org12-7h.htm, 2010, October 22.

PacificWreck.com. (2011). SMS Cormoran. Retrieved from http://www.pacificwrecks.com/ships/german/sms_cormoran.html, October 22, 2011.

Rainbird, P. (2004). The Archaeology of Micronesia. New York: Cambridge University Press.

United Nations Educational, Scientific, and Cultural Organization. (2012).Rock Island Southern Lagoon, Palau. Retreived from http://www.whc.unesco.org/en/list/1386, August 5, 2012.

U.S. Air Force. (2011). Integrated Cultural Resources Management Plan for Andersen Air Force Base, Guam, 2008 Update. Prepared by I. Prepared by International Archaeological Research Institute, Honolulu, Hawai'i. Prepared for Prepared for the U.S. Air Force Center for Engineering and the Environment and 36 CES/CEVN, Andersen Air Force Base, Guam.

U.S. Department of Defense. (2009). Programmatic Agreement Among the Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau, Joint Region Marianas; Commander, Navy Region Marianas; Commander, 36th Wing, Andersen Air Force Base; the Guam Historic Preservation Officer, and the Commonwealth of the Northern Marianas Islands Historic Preservation Officer Regarding Military Training in the Marianas.

U.S. Department of Defense. (2011). Programmatic Agreement Among the Department of Defense, the Advisory Council on Historic Preservation, the Guam Historic Preservation Officer, the Commonwealth of the Northern Marianas Islands Historic Preservation Officer, and the National Park Service Regarding Undertakings Associated with the Joint Guam and Commonwealth of the Northern Marianas Build Up Project on the Island of Guam and Throughout the Commonwealth of the Northern Marianas.

U.S. Department of the Navy. (2003). Updated Cultural Resources Management Plan for the Tinian Military Lease Area (MLA). Prepared by H. D. T. Prepared by M.J. Tomonari-Tuggle, & David J. Welch, International Archaeological Research Institute, Inc., Honolulu, Hawai'i. Prepared for Prepared for the Commander: Navy Region Marianas, Department of the Navy, Naval Facilities Engineering Command, Pacific, Pearl Harbor, Hawai'i.

U.S. Department of the Navy. (2005a). Cultural Resources Synthesis for COMNAVREG Marianas Lands, Guam. Prepared by J. R. M. David J. Welch, Amanda A. Morgan, & Sandra Lee Yee, International Archaeological Research Institute, Inc., Honolulu, Hawai'i. Prepared for Department of the Navy, Naval Facilities Engineering Command, Pacific, Pearl Harbor, Hawai'i.

U.S. Department of the Navy. (2005b). Regional Integrated Cultural Resources Management Plan for COMNAVREG Marianas Lands, Volume I: Guam, and Volume II: Tinian Military Lease Area (MLA). Prepared by I. Prepared by International Archaeological Research Institute, Honolulu, Hawai'i. Prepared for Prepared for the Commander, Navy Region Marianas, Department of the Navy, Naval Facilities Engineering Command, Pacific, Pearl Harbor, Hawai'i.

U.S. Department of the Navy. (2010). Tinian North Field Cultural Landscape Report. In Department of the Navy (Ed.) (Vol. Contract N62742-06-D-1870, Task Order 0007). Pearl Harbor, Hawaii: Navy Facilities Engineering Command, Pacific. Prepared by AECOM in association with TEC Joint Venture, Inc.

Welch, D. J. (2010). Archaeological Surveys and Cultural Resources Studies on the Island of Guam in Support of the Joint Guam Build-Up Environmental Impact Statement. (Vol. Volume I: Narrative). Pearl Harbor, Hawaii. Prepared for Department of the Navy, Naval Facilities Engineering Command, Pacific.

Zander, C. & Varmer, O. (1996, Last updated 2/23/2012). Contested Waters. In *Common Ground*. 2 ed. Retrieved from http://www.nps.gov/archeology/cg/vol1_num3-4/gaps.html

This Page Intentionally Left Blank

3.12 Socioeconomic Resources

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

This Page Intentionally Left Blank

3.12 SOCIOECONOMIC RESOURCES

SOCIOECONOMIC RESOURCES SYNOPSIS

The United States Department of the Navy considered all potential stressors, and the following have been analyzed for socioeconomic resources:

- Accessibility (limiting access to the ocean and the air)
- Physical disturbance and strike (aircraft, vessels, in-water devices, and military expended materials)
- Airborne acoustics (weapons firing, aircraft, and vessel noise)
- Secondary

Preferred Alternative (Alternative 1)

- Accessibility: Accessibility stressors are not expected to impact commercial transportation and shipping, commercial and recreational fishing, subsistence use, or tourism, because inaccessibility to areas of co-use would be temporary and of short duration (hours). The military will continue to collaborate with local communities to enhance existing means of communications with the aim of reducing the potential effects of limiting access to areas designated for use by the military.
- Physical disturbance and strike: Physical disturbance and strike stressors are not expected to result in impacts on commercial and recreational fishing, subsistence use, or tourism because the vast majority of military training and testing activities would occur in areas of the Study Area far from the locations of these socioeconomic activities. Furthermore, the large size of the Study Area over which these types of military activities would be distributed, and adherence to the Navy's standard operating procedures, would further reduce any potential for impacts.
- Airborne acoustics: Airborne acoustic stressors are not expected to result in impacts to tourism or recreational activities, because the vast majority of military training and testing activities would occur far out to sea in areas of the Study Area far from tourism and recreation locations.
- Secondary: Secondary stressors are not expected to result in impacts to commercial or recreation fishing, subsistence use, or tourism, based on the level of impacts described in other resources sections.

3.12.1 INTRODUCTION AND METHODS

This section provides an overview of the characteristics of socioeconomic resources in the Mariana Islands Training and Testing (MITT) Study Area and describes in general terms the methods used to analyze potential impacts on these resources from the Proposed Action.

Regulations from the President's Council on Environmental Quality implementing the National Environmental Policy Act (NEPA) state that "when an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the Environmental Impact Statement will discuss all of these effects on the human environment" (40 Code of Federal Regulations [C.F.R.] 1508.14). The Council on Environmental Quality regulations state that the "human environment shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." To the extent that the ongoing and proposed United States (U.S.) Department of the Navy (Navy) training and testing activities in the MITT Study Area could affect the economic or social and natural or physical environment, the socioeconomic analysis evaluates how elements of the human environment might be affected. The Navy identified four broad socioeconomic elements based on their association with human activities and livelihoods in the MITT Study Area (Chapter 2, Description of Proposed Action and Alternatives, and Figure 3.12-1). Each of these socioeconomic resources is an aspect of the human environment that involves economics (i.e., employment, income, or revenue) and social conditions (i.e., enjoyment and quality of life) associated with the marine environment of the MITT Study Area. This evaluation considered potential impacts on four socioeconomic elements in the MITT Study Area:

- Commercial transportation and shipping
- Commercial and recreational fishing
- Subsistence use
- Tourism

These four elements were chosen as the focus of the analysis in this chapter because of their importance to the local economy and the way of life on the Commonwealth of the Northern Mariana Islands (CNMI) and the potential for these elements to be impacted from military activities. As described below, the ports in the CNMI and Guam serve as an important link for commercial transit between Japan, Asia, and the United States. Fishing continues to be both a way of life and a source of revenue, either directly or indirectly, for many if not most residents of the CNMI and Guam (Kerr 2011; Western Pacific Regional Fishery Management Council 2009). In addition, tourists visiting the Marianas archipelago also take part in recreational fishing activities. Being dependent on the resources of the marine environment to obtain the necessities of life (e.g., food, shelter) is what is meant by subsistence use in this section. Although, resources (e.g., fisheries) of the marine environment were essential to the ancestors of the Chamorro for survival, other sources of income mitigate the dependence on harvesting natural resources (Amesbury and Hunter-Anderson 2003; van Beukering et al.2007). The Navy recognizes the cultural and economic value of these activities and their dependence on having access to areas of the marine environment essential to preserving local culture and sustaining the local economy. Access to marine areas important to fishers, both for commercial and recreational use, is, and has been, a concern of the local population. Access to the same or other areas is also important for subsistence as well as tourism (e.g., fishing and whale watching). The Navy strives to address these concerns in this chapter.

With the collapse of the garment industry from approximately 2006 to 2009, tourism is widely recognized as the major industry in the Marianas archipelago (Aldan-Pierce 2011; First Hawaiian Bank 2011). As indicated in Chapter 2 (Description of Proposed Action and Alternatives), implementation of the Proposed Action would have no impact on land-based agricultural activities or on lease back areas. The baseline for identifying the socioeconomic conditions in the MITT Study Area was derived using relevant published information from sources that included federal, state, regional and local government agencies and databases, academic institutions, conservation organizations, technical and professional organizations, and private groups. Previous environmental studies were also reviewed for relevant information.

The alternatives were evaluated based upon the potential and the degree to which training and testing activities could impact socioeconomics. The potential for impacts depends on the likelihood that the training and testing activities would interface with public activities or infrastructure. The analysis considered both temporal and spatial scales when evaluating potential interfaces between the public or infrastructure and military training and testing. To estimate the degree to which interface could impact socioeconomics, the potential for impacts on livelihood, quality of experience, resource availability, income, or employment are considered. If there is no expected potential for the public to interface with an activity, the impacts would be considered negligible.

3.12.2 AFFECTED ENVIRONMENT

The area of interest for assessing potential impacts on socioeconomic resources is the international waters south of Guam to north of Pagan and from the Pacific Ocean east of the Mariana Islands to the Philippine Sea to the west. This section describes the four most relevant socioeconomic topics associated with human activities and livelihoods in the MITT Study Area.

3.12.2.1 Commercial Transportation and Shipping

Commercial transport is a vital part of the economy of Guam and the CNMI and includes the shipping of goods as well as the transport of residents and tourists. Current military and civilian use of the offshore sea space and air space is compatible. Navy ships account for 6 percent of the total ship presence out to 200 nautical miles (nm) (Mintz and Filadelfo 2011). The military conducts training and testing activities in operating areas away from commercially used waterways and inside special use airspace (SUA). Scheduled activities are published for access by all vessels and operators by use of Notices to Mariners (NOTMARs) issued by the U.S. Coast Guard and Notices to Airmen (NOTAMs) issued by the Federal Aviation Administration (FAA). In addition, the U.S. Navy Hydrographic Office in the Pacific will issue a HYDROPAC, which is a warning of navigational danger, prior to conducting an activity requiring such an announcement (e.g., training activity using explosives).

The Department of Defense (DoD) also publishes separate NOTAMs about runway closures, missile launches, special traffic management procedures, and malfunction of navigational aids. The U.S. Coast Guard retains publication of NOTMARs, which advises mariners of important matters affecting navigational safety, including new hydrographic discoveries, changes in channels and navigational aids, hazards to navigation, and other items of marine information of interest to mariners on the waters of the United States.

3.12.2.1.1 Ocean Traffic

Ocean traffic is the transit of commercial, private, or military vessels at sea, including submarines. The ocean traffic flow in congested waters, especially near coastlines, is controlled by the use of directional shipping lanes for large vessels, including cargo, container ships, and tankers. Traffic flow controls are also implemented to ensure that harbors and ports-of-entry remain as uncongested as possible. There is less control on open-ocean traffic involving recreational boating, sport fishing, commercial fishing, and activity by naval vessels. In most cases, the factors that govern shipping or boating traffic include the following: adequate depth of water, weather conditions (primarily affecting recreational vessels), availability of fish, and water temperature. Higher water temperatures are correlated with an increase in recreational boat traffic, jet skis, and scuba diving activities. Most shipping lanes are located close to the coast but those that are trans-oceanic start and end to the northwest of Guam.

Areas of surface water within the MITT Study Area are designated as danger zones and restricted areas as described in the C.F.R., Title 33 (Navigation and Navigable Waters), Part 334 (Danger Zone and Restricted Area Regulations) and established by the U.S. Army Corps of Engineers. Danger zones are areas used for target practice, bombing, rocket firing, or other especially hazardous training operations.

A danger zone may be closed to the public full-time or on an intermittent basis, as stated in the regulations. A restricted area is designated for the purpose of prohibiting or limiting public access to an area. Restricted areas generally provide security for government property and protection to the public from risks of damage or injury arising from government activities occurring in the area (33 C.F.R. 334.2). A detailed discussion of danger zones and restricted areas located in the MITT Study Area is provided in Chapter 2 (Description of Proposed Action and Alternatives, Figure 2.7-1 and Table 2.7-1).

3.12.2.1.1.1 Guam

In the western Pacific Ocean, four waterways used by commercial vessels link Guam and the CNMI with major ports to both the east and west (Figure 3.12-1). Guam contains one commercial port located within Apra Harbor. The Port of Guam is the largest U.S. deepwater port in the Western Pacific and handles approximately 2 million tons (1,814,369,480 kilograms [kg]) of cargo a year (Port Authority of Guam 2011). The United States provides some 60 percent of Guam's imported goods, with the balance of Guam's trade coming from the Asian and Pacific markets of Japan, Taiwan, the Philippines, Hong Kong, and—to a lesser extent—Australia, New Zealand, and the islands of Micronesia (Port Authority of Guam 2011). Apra Harbor also provides economical transshipment services from the United States, Hawaii, and East Asia to the entire western Pacific.

Federally regulated nearshore areas in Guam waters include Danger Zones, Restricted Areas, Safety Zones, and Anchorages. These areas are established to maintain security, public and maritime safety.

- The Orote Point Small Arms Range danger zone extends west of Orote Point and is located south of the entrance to Apra Harbor (see Chapter 2, Description of Proposed Action and Alternatives, Figure 2.1-5) (33 C.F.R. 334.1420).
- The U.S. Coast Guard has designated a restricted area in the waters of Inner Apra Harbor and adjacent waters of Outer Apra Harbor prohibiting all swimmers, vessels, and other craft except public vessels of the United States from entering the area without prior permission (33 C.F.R. 334.1430).
- The U.S. Coast Guard has designated two safety zones (Safety Zone A for commercial Wharf H, and Safety Zone B for Naval Wharf Kilo) in Apra Harbor (33 C.F.R. 165.1401). During times when these safety zones are in effect, entry into these zones is prohibited unless authorized by the Captain of the Port, Guam.
- The U.S. Coast Guard has designated Naval anchorage areas in Apra Harbor (33 C.F.R. 110.238). (See Chapter 2, Description of Proposed Action and Alternatives, Figure 2.1-5).

In these areas, the military may request that the U.S. Army Corps of Engineers and the U.S. Coast Guard enforce these rules by requesting that unauthorized personnel leave the area.

Surface exclusion zones are defined as temporary hazard areas associated with explosive ordnance disposal (EOD) activities. The U.S. Coast Guard may establish temporary safety zones around exclusion zones in nearshore waters. Training and testing sites with exclusion zones in nearshore waters located within 3 nm of Guam include the Piti Floating Mine Neutralization Site, the Agat Bay Mine Neutralization Site, the Outer Apra Harbor Underwater Detonation Site, and the Pati Point EOD Range (see Chapter 2, Description of Proposed Action and Alternatives, Figures 2.1-9 and 2.7-1). Exclusion zones that are associated with divers conducting underwater detonations will have a minimum surface exclusion zone radius of 2,100 feet (ft.) (640 meters [m]); however, the final determination of exclusion zone size is made prior to each event and is dependent of the specifics of the event. The public is notified by local

NOTMARs of events using danger zones, nearshore exclusion zones, and U.S. Coast Guard designated temporary safety zones.

3.12.2.1.1.2 Commonwealth of the Northern Mariana Islands

The CNMI is a 14-island chain that features the three main islands of Saipan, Tinian, and Rota. There are three ports within the CNMI. The Port of Rota, or Rota West Harbor, is located on the southwestern tip of the island. It is classified as a very small port by the World Port Source which also describes the harbor as small and poorly sheltered (World Port Source 2012a). The port includes a jetty or wharf with a pierside water depth of 6 to 10 ft. (2 to 3 m) which limits the size of vessels that can access the pier. The Port of Rota is mainly used as a port for ferry boats transporting tourists and residents from its sister island, Tinian. The Commonwealth Ports Authority is seeking funding to dredge the harbor and upgrade the port facilities in preparation for possible future development on the island (Commonwealth Ports Authority 2005). The Port of Tinian is described by the World Port Source as a small port offering excellent shelter, which is provided by a coastal breakwater. Three finger piers and a small boat ramp are available at the port. Pierside water depth ranges from 26 to 30 ft. (7.1 to 9 m), allowing relatively large vessels to dock. Mobile Oil operates a fuel plant at the port, and a ferry service transports tourists from Saipan to the hotel and casino, which is one of the main attractions on Tinian (Commonwealth Ports Authority 2005; World Port Source 2012b).

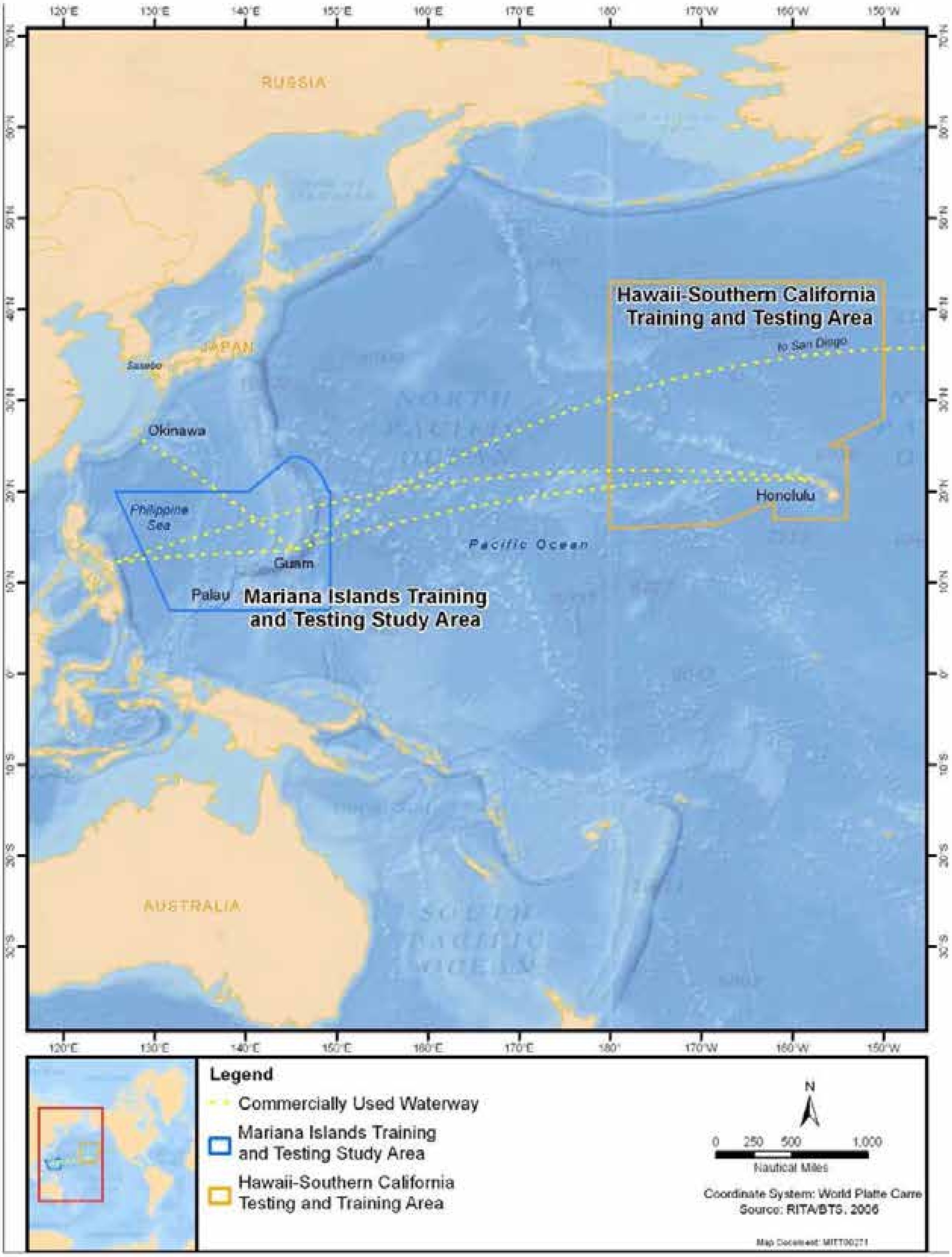


Figure 3.12-1: Shipping Lanes within the Mariana Islands Training and Testing Study Area

The Port of Saipan is the largest and most advanced of the three ports, but is nevertheless described as a small seaport with poor shelter by the World Port Source. A number of facilities and services are available at the port, including a cargo terminal with pierside water depth ranging from 16 to 20 ft. (4.9 to 6.1 m) and an oil terminal with a 21 to 25 ft. (6.4 to 7.6 m) depth range (World Port Source 2012c). In addition, approximately 2,600 linear ft. (790 m) of berthing space, cranes and lifts capable of handling loads over 100 tons, and a 22-acre (ac.) (8.9-hectare [ha]) container yard enabled the port to transfer over 338,000 tons of cargo in 2009 (Commonwealth Ports Authority 2005, 2010).

There are two sections to the Port of Saipan; one is the Garapan Anchorage which is located in the outer harbor, and the other is the Puetton Tanapeg harbor which is sheltered by a barrier reef to the north and considered the inner harbor. The port of Saipan is on the southwest shore and houses commercial ships, small local boats or ferries, and U.S. Navy ships.

Farallon de Medinilla (FDM) and the nearshore waters have been leased to the United States for military purposes since 6 January 1983 (U.S. Department of the Navy 2009), specifically for use as a live-fire naval gunfire and air warfare air strike training range. FDM and nearshore waters extending to 3 nm from the island are restricted to all personnel both civilian and military due to safety concerns over unexploded ordnance. The lease agreement between the CNMI and the United States notes in Article 12 of the lease: "FDM: Public access to FDM Island and the waters of the Commonwealth immediately adjacent thereto shall be permanently restricted for safety reasons." The restriction around FDM and nearshore areas prohibits the entry of all personnel, civilian and military, to the island without specific permission from Commander, Joint Region Marianas (Commonwealth of the Northern Mariana Islands 1983).

The Mariana Islands Range Complex Airspace Environmental Assessment (EA)/Overseas EA (OEA) analyzed extending the proposed danger zone surrounding FDM from 10 nm to 12 nm, congruent with restricted area airspace R-7201A discussed in Section 3.12.2.1.2 (Air Traffic) (U.S. Department of the Navy 2013). The analysis supports the establishment of the expanded Danger Zone under the authority of the U.S. Army Corps of Engineers (C.F.R., Title 33 Part 334) to restrict all private and commercial vessels from entering the area during hazardous training and testing activities. Additional information on danger zones and restricted areas in the MITT Study Area is provided in Chapter 2 (Description of Proposed Action and Alternatives).

3.12.2.1.1.3 Transit Corridor

Major commercial shipping vessels use the shipping lanes for shipping goods between Hawaii, the continental United States, and Asia. However, there are no direct routes between Guam and the United States; stops are made in Asia, and usually Japan or Korea, before continuing on to either Hawaii or the continental United States. Vessels using shipping lanes are outside of military training areas and typically follow all U.S. Coast Guard maritime regulations. The total number of vessels transiting through the Port of Guam has steadily decreased from 2,924 in 1995 to 1,022 in 2008 (U.S. Department of the Navy 2010a). The decrease is most pronounced in the number of barges and fishing vessels that transit through the Port. From 1995 to 2008 the number of barges decreased from a high of 169 to a low of 17, and the number of fishing vessels decreased from 2,161 to 586. However, the number of container ships has increased from a low of 103 in 2003 to a high of 165 in 2008. The Port of Guam handled over 99,000 containers in fiscal years (FY) 2007 and 2008. FY 2009 through 2011 saw a decrease in the number of containers to 96,000 (Port Authority of Guam 2012). Most other types of cargo passing through the Port of Guam, including break-bulk cargo (e.g., cargo packed in cases, drums, and bales, etc.), bulk cargo, and roll-on-roll-off cargo (e.g., automobiles) has decreased substantially from a high of 477 in 1995 to 171 (the second lowest annual total) in 2008 (U.S. Department of the Navy 2010a).

3.12.2.1.2 Air Traffic

Air traffic refers to movements of aircraft through airspace. Safety and security factors dictate that use of airspace and control of air traffic be closely regulated. Accordingly, regulations applicable to all aircraft are promulgated by the FAA to define permissible uses of designated airspace, and to control that use. These regulations are intended to accommodate the various categories of aviation, whether military, commercial, or general aviation.

The system of airspace designation uses various definitions and classifications of airspace in order to facilitate control. Airspace can be generally categorized as "controlled airspace" or "uncontrolled" airspace.

- "Victor Routes" are the networks of airways serving commercial aviation operations up to 18,000 ft. (5,486 m) above mean sea level (MSL).
- Class A is controlled airspace extending from 18,000 ft. (5,486 m) above MSL up to and including 60,000 ft. (18,288 m) above MSL and includes designated airways for commercial aviation operations at those altitudes.
- Class B is controlled airspace extending from the surface to 10,000 ft. (3,048 m) above ground level surrounding the nation's busiest airports.
- Class C and D airspace are controlled areas around certain airports, tailored to the specific airport.
- Class E is controlled airspace not included in classes A, B, C, or D.
- Class F airspace is not used in the United States.
- Class G is uncontrolled airspace (i.e., not designated as Class A–E).

Special use airspace consists of both controlled and uncontrolled airspace and has defined dimensions where flight and other activities are confined because of their nature and the need to restrict or prohibit non-participating aircraft for safety reasons. Special use airspace is established under procedures outlined in 14 C.F.R. Part 73.1. The majority of SUA is established for military flight activities and, with the exception of prohibited areas (e.g., over the White House) may be used for commercial or general aviation when not reserved for military activities. There are multiple types of SUA, including prohibited, restricted, warning, alert, and military operations areas (Federal Aviation Administration 2009). One type of SUA of particular relevance to the MITT Study Area is a warning area, which is defined in 14 C.F.R. Part 1 as follows:

> "A warning area is airspace of defined dimensions, extending from 3 nm outward from the coast of the United States that contains activity that may be hazardous to non-participating aircraft. The purpose of such warning areas is to warn non-participating pilots of the potential danger. A warning area may be located over domestic or international waters or both."

Warning areas are established to contain a variety of hazardous aircraft and non-aircraft activities, such as aerial gunnery, air and surface missile firings, bombing, aircraft carrier operations, and naval gunfire. When these activities are conducted in international airspace, the FAA regulations may warn against, but do not have the authority to prohibit, flight by non-participating aircraft. A restricted area, such as R-7201, is a type of SUA within which nonmilitary flight activities are closely restricted.

3.12.2.1.2.1 Guam

Military Air Transit

Military aircraft originating from Guam would most often transit to one of the three warning areas located south of Guam (Figure 3.12-2). Warning Area (W)-517 overlays deep ocean waters and is located south-southwest of Guam. The northernmost boundary of W-517 is approximately 8 nm from the southern tip of Guam (Figure 3.12-2). W-517 provides a large SUA area extending from surface to unlimited altitude (Table 3.12-1). W-517 is constrained by commercial air traffic lanes to the east and west. W-11A/B is located east of W-517 and also overlays deep ocean waters. The northernmost boundary of W-11 is approximately 30 nm south-southeast of the southern tip of Guam. W-12 is adjacent to the southern boundary of W-517 and extends SUA approximately 30 nm farther south. The northernmost boundary of W-12 is approximately 120 nm from southern Guam.

Open ocean Air Traffic Control Assigned Airspace (ATCAA) within the MITT Study Area is used for military training and testing activities, from unit-level training to major joint exercises. ATCAAs 5 and 6, as depicted in Figure 3.12-2, have been pre-assigned in agreements between Guam Air Route Traffic Control Center; Commander, U.S. Naval Forces Marianas (COMNAVMAR); and 36th Operations Group. COMNAVMAR is designated as the scheduling and using agency for W-517 and ATCAAs 5 and 6. Guam Air Route Traffic Control Center is designated as the Controlling Agency. The Guam Air Route Traffic Control Center works with COMNAVMAR and 36th Wing to modify or configure new ATCAAs as required for training and testing activities. Preconfigured ATCAAs 5 and 6 encompass 25,800 square nautical miles (nm^2), extending from south of Guam to north of Saipan, and to the east of Guam (Table 3.12-1).

ATCAAs are activated for short periods to cover the time frames of training and testing activities. COMNAVMAR coordinates ATCAA requests with the FAA and 36th Wing. If the preconfigured ATCAA 5 or 6 do not meet the need for a special event, then event-specific ATCAAs in the location, size, and altitude for the time frame needed may be requested contingent on agreement of the FAA and coordination with COMNAVMAR and 36th Wing.

Andersen Air Force Base contains one airfield, Main Base, which is approximately 4,500 ac. (1,821.1 ha). Airspace over Main Base supports takeoffs and landings of all types of aircraft up to and including the C-5. Andersen Air Force Base airspace is controlled by Air Force air traffic control.

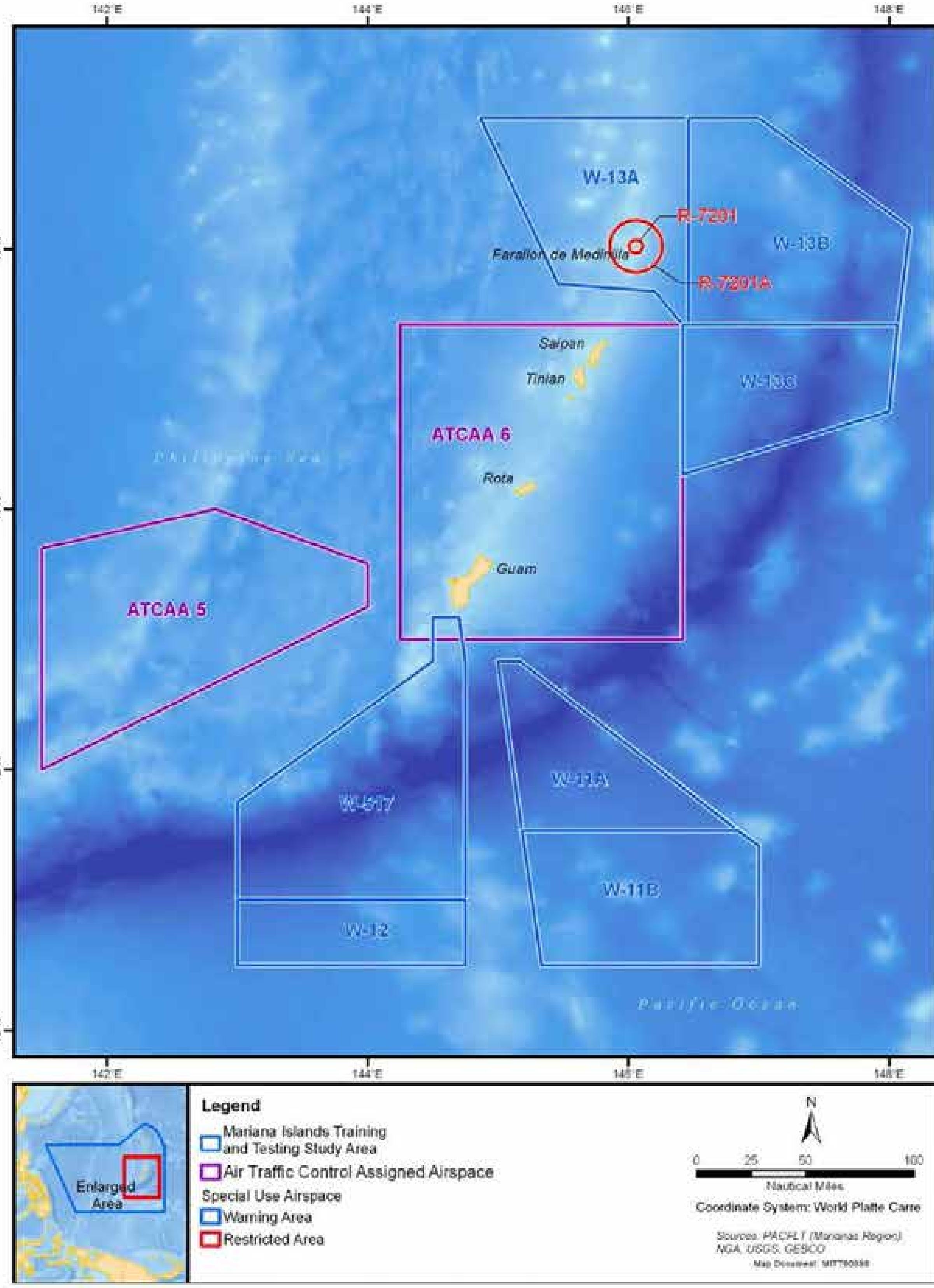


Figure 3.12-2: Mariana Islands Training and Testing Study Area Airspace

Table 3.12-1: Warning Areas, Restricted Airspace, and Air Traffic Control Assigned Airspace in the Mariana Islands Training and Testing Study Area

MITT Study Area Airspace				
Airspace	**Surface Area (nm^2)**	**Lower Altitude Limit (ft.)**	**Upper Altitude Limit (ft.)**	**Over Land?**
W-11A	4,165	Surface	30,000	No
W-11B	6,306	Surface	30,000	No
W-517	8,353	Surface	Unlimited	No
W-12	3,093	Surface	Unlimited	No
W-13A Low	5,940	Surface	35,000	No, except for FDM
W-13A High		35,000	60,000	
W-13B Low	7,724	Surface	30,000	No
W-13B High		30,000	60,000	
W-13C Low	5,064	Surface	30,000	No
W-13C High		30,000	60,000	
R-7201	28	Surface	60,000	No, except for FDM
R-7201A	424	Surface	60,000	No
ATCAA 5	10,394	Surface	30,000	No
ATCAA 6	18,271	39,000	43,000	No, except for Guam, CNMI[1]

[1] ATCAA 6 is primarily over water, but Guam, Rota, Tinian, and Saipan lie beneath it.
Notes: nm^2 = square nautical miles, ft. = feet, W = Warning Area, R = Restricted Area, ATCAA = Air Traffic Control Assigned Airspace

Commercial and General Aviation

Guam International Air Terminal is the only civilian air transportation facility on Guam. It is operated by Guam International Airport Authority, a public corporation and autonomous agency of the Government of Guam. Guam International Air Terminal contains two runways and facilities that are part of the now-closed Naval Air Station Agana. Eight major airlines operate out of Guam International Air Terminal, making it a hub of air transportation for Micronesia and the Western Pacific (Figure 3.12-3).

3.12.2.1.2.2 Commonwealth of the Northern Mariana Islands

Military Air Transit

ATCAA 6 overlies both the Guam and the CNMI (see Figure 3.12-2). On Tinian, the military conducts aviation training in the military lease area by delivering personnel and cargo to maneuver areas, and providing various support functions to forces already on the ground, such as cargo delivery, firefighting, and search and rescue. An important feature in the Exclusive Military Use Area is North Field, a large abandoned World War II era airfield. Although improvements are needed to ensure that the facilities on North Field meet safety and operational requirements, the airfield can be used as a contingency land airfield to support fixed-wing and helicopter training activities. North Field's four runways, taxiways, and parking aprons provide various tactical scenarios without interfering with commercial and community activities south of the military lease area. The remote area is suitable for a variety of aviation support training. Use of North Field would also reduce or eliminate the need to share West Tinian Airport with commercial flight activity.

W-13A/B/C is located approximately 20 nm north-northeast of the northern tip of Saipan. W-13 extends from the surface to an upper altitude of 60,000 ft. (18,288 m) (see Table 3.12-1). W-13A overlays FDM and surrounds R-7201 and R-7201A (see Figure 3.12-2). On FDM, R-7201 is a restricted airspace with a 3 nm radius surrounding the island, and R-7201A is an adjacent restricted airspace extending from 3nm out to 12 nm from FDM (Figure 3.12-4). The surface area defined by the 3 nm radius encompasses 28 nm^2, and the surface area defined by the 12 nm radius encompasses 452 nm^2. Published NOTMARs and NOTAMs will occasionally advise out to and beyond a 12 nm radius depending on the nature of the training activities being conducted. The altitude limits for both R-7201 and R-7201A are surface to 60,000 ft. (18,288 m). The FDM range supports live-fire and inert training activities such as surface-to-ground and air-to-ground gunnery exercises, bombing exercises, missile exercises, Fire Support, and Precision Weapons. Additional information on restricted airspace in the MITT Study Area is provided in Chapter 2 (Description of Proposed Action and Alternatives).

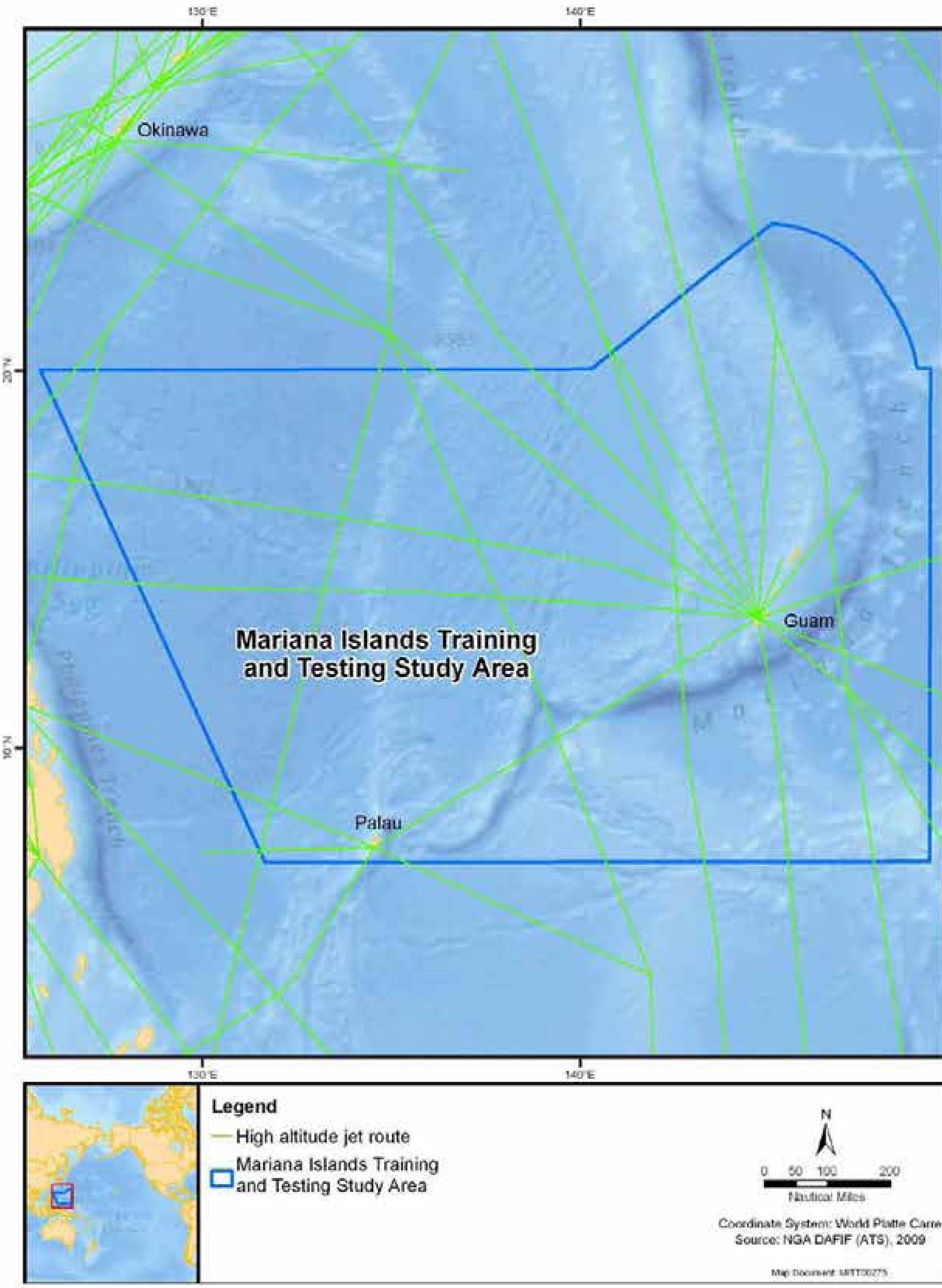


Figure 3.12-3: Commercial Airways within the Mariana Islands Training and Testing Study Area

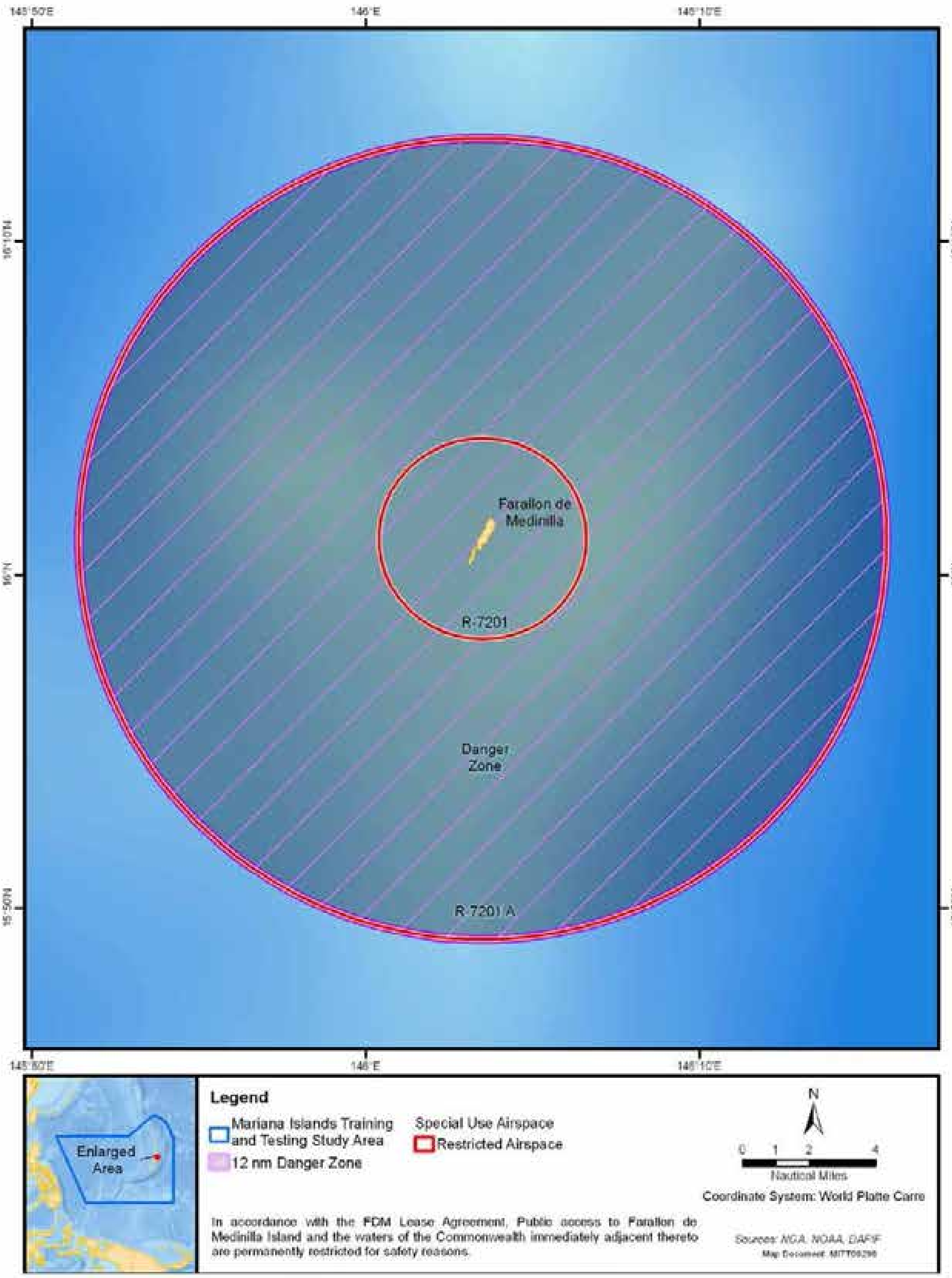


Figure 3.12-4: Farallon de Medinilla Restricted Area and Danger Zone

Commercial and General Aviation

Saipan International Airport is the largest commercial airport in the CNMI, and is the main gateway for commercial air traffic into the CNMI (Commonwealth Ports Authority 2005). The airport has an 8,700 ft. (approximately 2,700 m) runway with adjacent taxiways and can accommodate wide-body aircraft. Direct flights are available from major cities in Japan, Korea, China, and Guam. A commuter terminal services Tinian and Rota islands. On Tinian, all commercial flights fly into West Tinian Airport (or Tinian International Airport). The airport has one runway that is 8,600 ft. (approximately 2,600 m) by 150 ft. (46 m). Renovations to a departure terminal in support of direct flights to China are planned (Commonwealth Ports Authority 2005). The airport is equipped with a navigational light system for nighttime operations, but has no control tower or additional navigational aids. Rota International Airport has a 6,000 ft. (approximately 1,800 m) runway capable of handling Boeing 757 or 727 aircraft, but with load restrictions. Tinian and Rota airports primarily support inter-island flights between Tinian, Saipan, Rota, and Guam. All three airports are FAA certified.

On FDM, there is no civilian use of airspace around the island because it is a restricted area and available only to military traffic. NOTAMs usually advise of a 12 nm radius around FDM to be used exclusively by the military (Figure 3.12-4).

3.12.2.1.2.3 Transit Corridor

There are commercial air routes over the MITT transit corridor. However, commercial aircraft typically fly above 30,000 ft. (9,144 m) in this area. These air routes are controlled by the FAA.

3.12.2.2 Commercial and Recreational Fishing

Fishing is an integral part of the culture and way of life in the CNMI and Guam. Most fishers do not fish exclusively for commercial, recreational, or subsistence benefit but rather for some combination of the three (Hospital and Beavers 2012; Tibbats and Flroes 2012). Commercial fishing takes place throughout the MITT Study Area from nearshore waters adjacent to Guam and the CNMI, offshore banks, and pelagic waters. Sportfishing peaks in summer (June through August) when popular sport fish, including blue marlin and yellowfin tuna, are most abundant. Skipjack tuna are present year round, but are also most abundant in summer.

Mahi-mahi arrive in January and reach peak abundance in February or March, while wahoo typically have two peak abundances during the year in spring and fall. Jacks, snapper, and grouper are fished for off of reef flats surrounding the island (Schultz 2000).

Fishers in the CNMI typically fish in waters that are less than 500 ft. (152 m) deep and target the red-gilled emperor (Western Pacific Regional Fishery Management Council, n.d.). Fishing peaks in summer, but occurs year round in some locations (e.g., leeward side of the islands) where conditions are usually calmer. Some small-scale commercial fishing takes place in waters deeper than 500 ft. (152 m) and focuses on snapper and grouper species (Western Pacific Regional Fishery Management Council 2009).

3.12.2.2.1 Guam

Commercial and recreational fishing on Guam is typically divided into three types: bottom fishing, coral reef fishing, and pelagic fishing. A 2011 survey of 147 small boat fishers on Guam revealed the traditional and cultural importance of fishing to the people of Guam. Fishers responding to the survey reported having fished from boats for an average of 20 years (Hospital and Beavers 2012). Although 70 percent of fishers reported selling a portion (on average 24 percent) of their catch, the motivation was not to supplement their income, but mainly to defray some of the costs associated with fishing trips (e.g., fuel costs). Even though fishing is no longer the primary source of income for many fishers, it is an important part of the social and cultural history of the people of Guam, and it remains a vital part of local communities. This point is illustrated by the manner in which fishers distribute their catch. Respondents to the survey (Hospital and Beavers 2012) reported consuming 29 percent of their catch at home, giving away 42 percent of their catch, and selling 24 percent of their catch. The remaining balance was either released or used to barter for other goods.

Shore-based fishing accounts for most of the fish and invertebrate harvest from coral reefs. More than 100 species of fish are available in the waters around Guam. Fishing by hook and line is the most popular method of shore-based fishing, but other methods, including thrown net, gill net, drag net, and snorkel spear fishing are also used (Tibbats and Flores 2012). Reef fishing from small boats included bottom fishing and trolling as well as the use of nets and spear fishing. Eight-two percent of the fish caught on reefs were a combination of atulai (or bigeye scad), emperors, trevallys (members of the jack family), rabbitfish, surgeon fish, and miscellaneous reef fish (Tibbats and Flores 2012). However, many of the nearshore reefs around Guam appear to have been badly degraded due to sedimentation, tourist overuse, and overharvesting (Western Pacific Regional Fishery Management Council 2009).

According to the Western Pacific Regional Fishery Management Council, charter fishing has accounted for 15–20 percent of all bottomfishing trips from 1995 through 2004 (Western Pacific Regional Fishery Management Council 2009). These trips are generally to the same areas, 2–4 hours per day, with as many as 35 patrons per trip, and the majority of the catch is released back to the ocean (Western Pacific Regional Fishery Management Council 2009). Guam fishing for the crustacean fishery occurs for subsistence and recreation in inshore territorial waters.

Both commercial and recreational fishing activities generally originate from one of the three principal harbors located on the west coast and southern tip of the island. However, the following public boat launch sites are available (Figure 3.12-5):

- Agana Boat Basin – centrally located on the western leeward coast. Used for fishing areas off the central and northern leeward coasts and the northern banks
- Merizo Boat Ramp – provides access to the southern coasts, Cocos Lagoon, and the southern banks
- Seaplane Ramp in Apra Harbor – provides access to the southern coasts, Apra Harbor, Cocos Lagoon, and the southern banks
- Agat Marina – provides access to the southern coasts, Apra Harbor, Cocos Lagoon, and the southern banks
- Ylig Bay – provides access to the east (Pacific Ocean) side of the island
- Umatac Boat Ramp – located just north of Merizo Boat Ramp along the southwestern coast. Provides access to the Umatac Bay and the southern banks

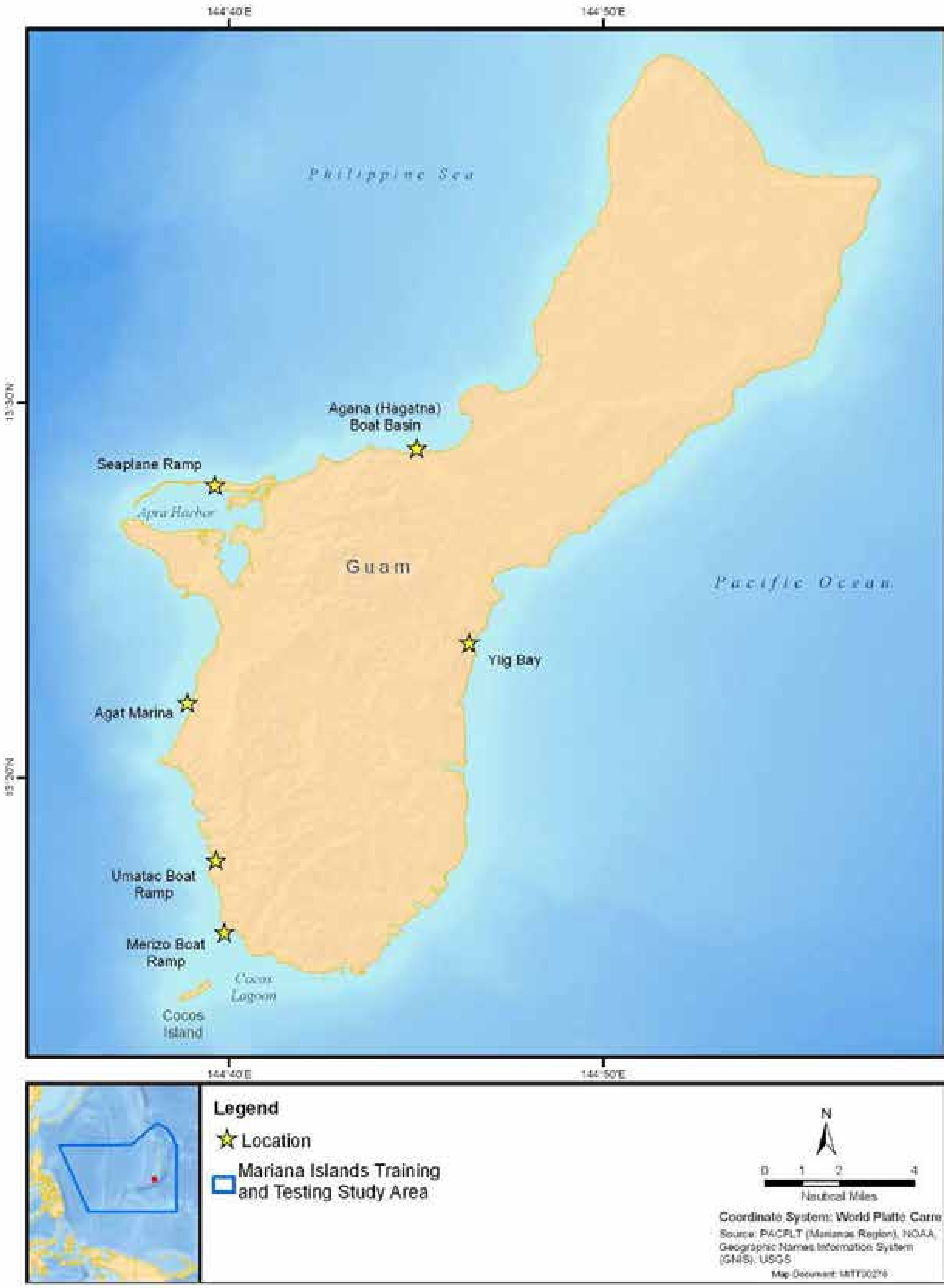


Figure 3.12-5: Guam Public Boat Launch Locations

The Guam bottomfish fishery is a combination of subsistence, recreation, and commercial fishing. The majority of vessels used for bottom fishing are less than 25 ft. (7.6 m) long and operate in shallow waters (< 500 ft. [152 m]) (Hospital and Beavers 2012). Bottom fishing on Guam is conducted in two areas: shallow water (< 500 ft. [152 m]) and deep water (> 500 ft. [152 m]). Smaller operator-owned boats tend to target shallow water, while the commercial fishers tend to target the deeper water. Less than 20 percent of shallow water harvests are taken beyond 3 nm from shore. This is largely due to deeper water and stronger currents farther out to sea (Western Pacific Regional Fishery Management Council 2009). Bottom fishing charters account for 15 to 20 percent of bottom fishing trips since 1995 and they have increasingly become catch-and-release activities (Western Pacific Regional Fishery Management Council 2009).

Pelagic fishing started on Guam during the 1950s along with the growth of the tourist industry. The five most common pelagic fish caught on Guam waters are mahi-mahi, wahoo, skipjack tuna, yellowfin tuna, and Pacific blue marlin. From year to year, there have been large fluctuations in the number of these species caught. Pelagic fish tend to be highly migratory and at the top trophic level of oceanic predators. The pelagic fishing fleet numbered 386 boats in 2006 (Allen and Bartram 2008). Approximately 7 percent of this fleet is comprised of charter boats with the remainder comprised of Guam residents using owner-operated boats, mostly towed to launch sites, as opposed to semi-permanent marina docking (Allen and Bartram 2008). The charter industry is most widely used by tourists and U.S. military personnel. Pelagic charter trips totaled roughly 2,000 in 2006, with an estimated 67,000 pounds (lb.) (30,400 kg) of catch with mahi-mahi, skipjack, and wahoo accounting for the top three species (Allen and Bartram 2008).

Annual commercial landings data for all fish types in Guam from 2005 to 2009 shows a fluctuation in the amount of pounds caught, and subsequently the revenue generated from these commercial fishing activities (Table 3.12-2). The 2008 Pacific Islands Fisheries Science Center released an administrative report titled *Guam as a Fishing Community* that notes that, although in some cases commercial fishing contributes substantially to household income, nearly all of Guam's domestic fishers hold jobs outside the fishery (Hospital and Beavers 2012; Allen and Bartram 2008; Myers 1993). Commercial fisheries have made a relatively minor contribution to Guam's economy. According to the Western Pacific Fisheries Information Network (WPacFIN), between 1980 and 2009, the ex-vessel value of domestic commercial landings ranged from about $179,000 in 1980 to $1.33 million in the year 2000 (Western Pacific Fisheries Information Network 2010). Since the late 1970s, the most important commercial fisheries activity in Guam has been the territory's role as a major regional fish transshipment center and resupply base for domestic and foreign tuna fishing fleets.

Table 3.12-2: Guam Commercial Fishery Landings

Year	Annual Total (lb.)	Value
2005	357,965	$748,036
2006	334,729	$726,296
2007	422,153	$889,221
2008	287,213	$692,809
2009	270,922	$711,463
TOTAL	**1,672,982**	**$3,767,825**

Note: lb. = pounds
Sources: Guam Division of Aquatic and Wildlife Resources and the Western Pacific Fishery Information Network 2007, 2008, 2009, 2010, 2011

In Guam, lobster is harvested out to 3 nm from shore and primarily for personal consumption. The commercial trade is relatively low with only 1,168 lb. (529.8 kg) caught and sold for $4,329 in 2008 (Guam Division of Aquatic and Wildlife Resources and the Western Pacific Fishery Information Network 2010). Shrimp and crab harvests have been attempted commercially, but are not of a reportable volume. Strong currents, rough bottom topography, and water depth where species occur result in high fishing gear loss when attempting to harvest these species. Four permits have been issued for crustacean harvest in the exclusive economic zone (EEZ) around Guam, but the results of the harvest are unknown.

Three prime, offshore fishing areas are located south-southwest of Guam along the northwestern boundary of W-517: Galvez Bank, Santa Rosa Reef, and White Tuna Banks (Figure 3.12-6). Galvez Bank is the closest of the three areas, located approximately 15 nm from the southern tip of Guam. Its greater accessibility (fishers from Guam would pass Galvez Bank in order to reach the other two areas) make Galvez Bank the most popular of the three areas. Galvez Bank is outside of W-517; however, the most direct route from Guam would cross the northernmost tip of W-517. Santa Rosa Reef is located on the western boundary of W-517 approximately 25 nm from Guam. As with Galvez Bank, Santa Rosa Reef is outside of W-517, but the most direct transit route would require transiting through W-517. White Tuna Banks is the farthest of the three fishing areas, located approximately 28 nm from Guam.

Trolling and bottomfishing are used at all three offshore fishing areas (Allen and Bartram 2008). At the Galvez Bank and Santa Rosa Reef, bottomfish are caught by a combination of recreational vessels (< 25 ft. [7.6 m]) and larger commercial vessels (> 25 ft. [7.6 m]) (Moffitt et al. 2007). Galvez Bank is fished most heavily because it is closest to shore, while Santa Rosa Reef and White Tuna Banks are fished only during the most favorable weather conditions, which usually occur between May and September. In 2005, personnel from the Coral Reef Ecosystem Division, Pacific Islands Fisheries Council, and National Marine Fisheries Service (NMFS) conducted coral reef assessments and monitoring at Galvez Bank and Santa Rosa Reef as part of the National Oceanic and Atmospheric Administration's (NOAA's) Coral Reef Conservation Program (Pacific Islands Fisheries Science Center 2006). The survey revealed the presence of very few large (> 50 centimeters total length) fish at Santa Rosa Reef. Only 39 individual large fish were seen during 5 days of surveys. Fish species diversity and abundance were also low at the bank. The most abundant species was the twin-spot snapper (Pacific Islands Fisheries Science Center 2006). Surveys at Galvez Bank were inhibited by strong currents, preventing divers from conducting in-water surveys. Steep drop-offs in bottom topography limited the use of underwater cameras. Additional surveys of Galvez Bank, Santa Rosa Reef, and White Tuna Banks are needed to better characterize species abundance and diversity.

Commercial vessels, which are generally longer than 25 ft. (7.6 m), often concentrate their efforts in deeper waters (> 500 ft. [152 m]), such that Galvez Bank is fished more often by commercial vessels than nearshore areas with similar bathymetric features. White Tuna Banks, Santa Rosa Reef, and Rota Banks are fished less often than Galvez Bank, because they are more remote requiring longer transit times, greater fuel costs, and because of concerns over safety, particularly for smaller boats, should there be a need to reach shore quickly. The offshore banks are subject to strong currents and are only accessible during exceptionally good weather. Local fishers have reported that up to 10 commercial boats use these banks when the weather permits. Less than 20 percent of the total shallow-water marine resources harvested in Guam are located beyond 3 nm from shore. (Western Pacific Regional Fishery Management Council 2009).

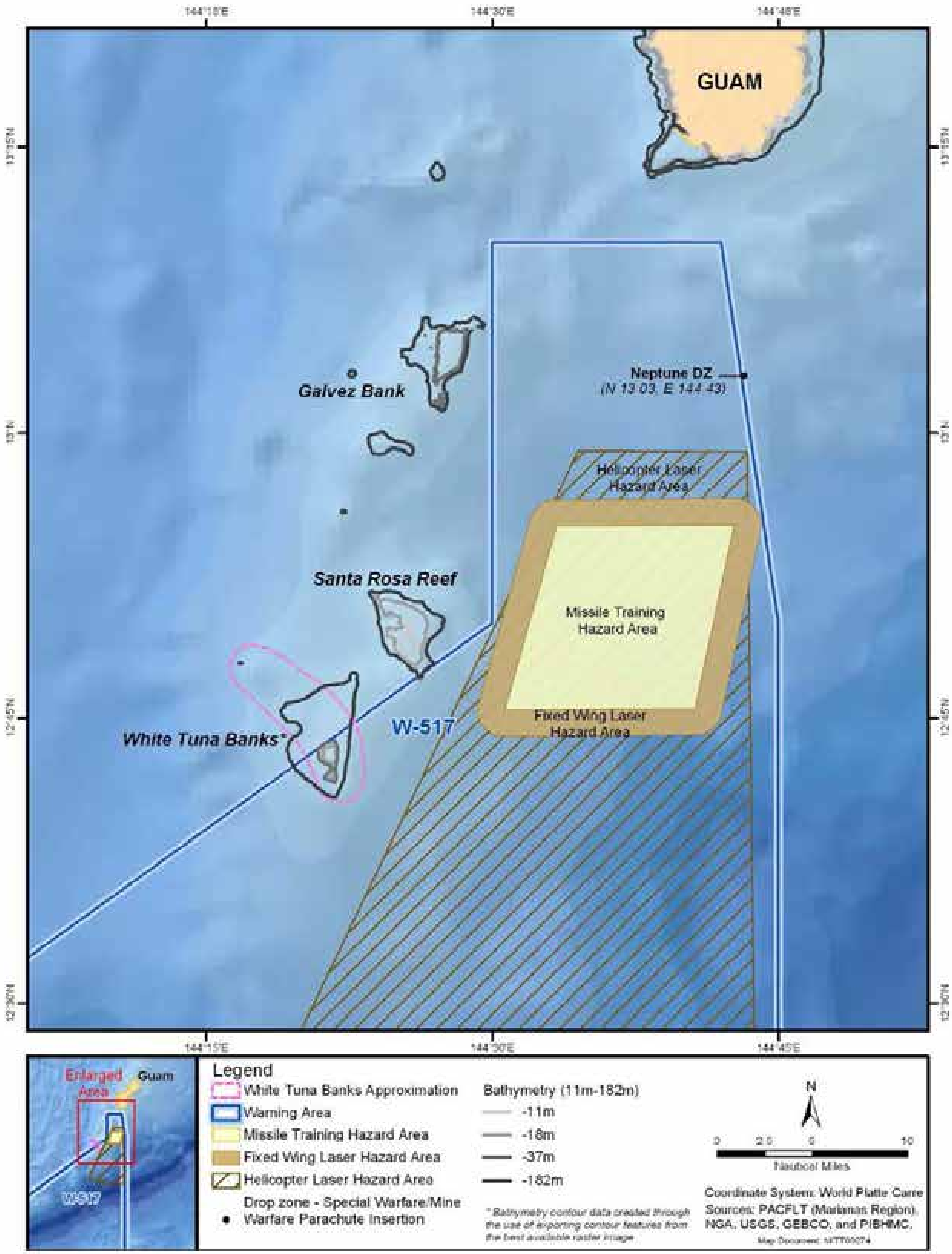


Figure 3.12-6: Galvez Bank and Santa Rosa Reef

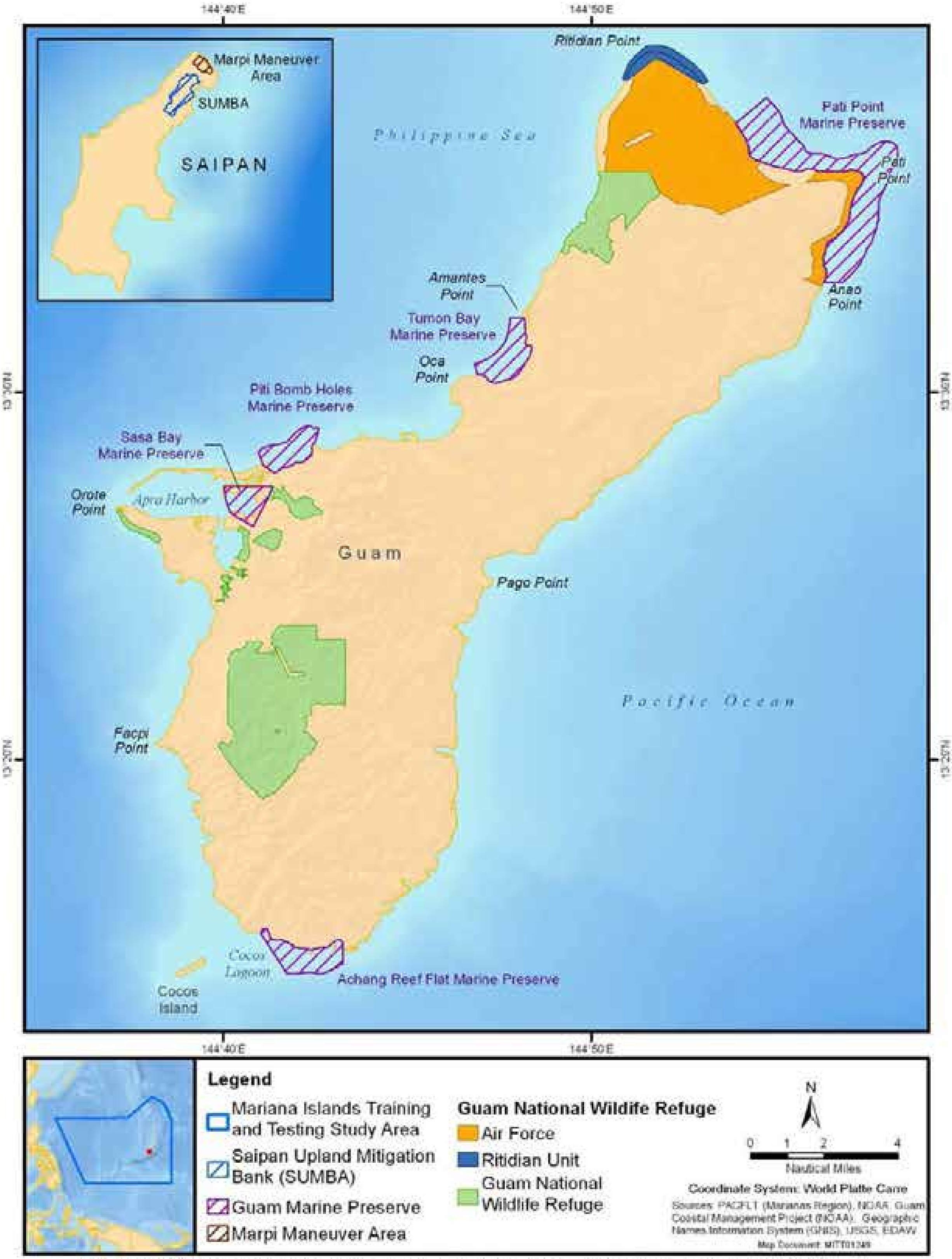
Guam has five marine preserves: Pati Point, Tumon Bay, Piti Bomb Holes, Sasa Bay, and the Achang Reef Flat Preserves (Figure 3.12-7). Public Law 24-21 was implemented to create the preserves and make changes to Guam's fishing regulations in an effort to preserve the fisheries (Guam Legislature 1997). Within the preserves, the taking of aquatic animals is restricted. All types of fishing, shell collecting, use of gaffs, and the removal of sand and rocks are prohibited unless specifically authorized. Limited inshore fishing is allowed within the Pati Point and Tumon Bay Preserves. Limited offshore fishing is also allowed in all the preserves.

3.12.2.2.2 Commonwealth of the Northern Mariana Islands

Fishing is part of the traditional and cultural heritage for the people of the CNMI and is practiced as much as a way of life than it is for recreation or a primary source of income (MacDuff and Roberto 2012). Both finfish and invertebrates are caught using a variety of techniques, including hook and line, cast netting, spear fishing, trolling, and bottom fishing. Shore-based and boat-based reef fishing is both popular on the CNMI. From boats, emperor fish make up the majority of the catch, and from shore, jacks, followed by emperor fish, comprise the majority of the catch (MacDuff and Roberto 2012).

For the CNMI, the Pacific Islands Fisheries Science Center published data for 2008 that was then compiled by the CNMI Division of Fish and Wildlife and the Western Pacific Fishery Information Network in August 2010. The Division of Fish and Wildlife collected data through a dealer invoicing system on a monthly basis. Estimates since 1982 indicate that more than 90 percent of the commercial landings have been recorded in Saipan, although the data represents 100 percent coverage (Guam Division of Aquatic and Wildlife Resources and the Western Pacific Fishery Information Network 2010). In order to commercially fish in the CNMI's EEZ in a 25–50 ft. (7.6–15 m) boat (over 5 net tons), a commercial fishing license is required and issued annually. The NOAA Pacific Islands Fisheries Science Center issues approximately four commercial fishing licenses on an annual basis (Pacific Islands Fisheries Science Center 2011). There has been a relatively stable catch from 2005 through 2009; however, associated revenues have been steadily decreasing. In 2009, the CNMI produced a low of 331,506 lb. (150,369 kg) of fish worth $709,985 The 5-year high of 536,724 lb. (247,453.9 kg) of fish worth $1,058,804 was recorded in 2006 (Table 3.12-3). The resultant average over this 5-year period was 440,025 lb. (199,592 kg) of fish worth an average of $891,314.

The CNMI bottomfish fishery occurs around the islands and banks from Rota Island to Zealandia Bank north of Sarigan in both the shallow water (100–500 ft. [30–152 m]) and the deep water (> 500 ft. [152 m]) fishing zones (MacDuff and Roberto 2012). Fishing in deeper waters is mainly conducted by larger, commercial vessels. Subsistence and recreational fishing occurs in the shallower waters. In 2004, the CNMI's Department of Fish and Wildlife reported 43 vessels recorded commercial landings in the bottomfish fishery (Western Pacific Regional Fishery Management Council 2005). Only eight of these vessels were reported to be larger commercial vessels, ranging in length from 29 to 70 ft. (8.8 to 21 m), and the remaining vessels were among the smaller, approximately 150 skiffs, measuring less than 24 ft. (7.3 m). The skiffs are generally restricted to use during daylight hours and within a 40 nm radius of Saipan because of their size (Western Pacific Regional Fishery Management Council 2005; MacDuff and Roberto 2012). Fishing gear used by recreational and subsistence fishers in the CNMI bottomfish fishery includes hand lines, home fabricated hand reels, and electric reels. Larger commercial vessels commonly use electric reels and hydraulics. There are no known commercial vessels with ice-making or freezer capabilities (Western Pacific Regional Fishery Management Council 2005). Bottomfishing is the most productive boat-based fishing method in the CNMI (MacDuff and Roberto 2012).



On May 16, 1997, Guam Public Law 24-21 was implemented creating 5 marine preserves and making changes to Guam's fishing regulations. These marine preserves were set up to restrict certain activities such as fishing to protect coral reef habitats and aquatic animals such as fish.

Figure 3.12-7: Marine Preserves on Guam and Saipan

Little information is available on the CNMI precious coral fishery. The steep topography around the islands limits the available habitat for precious coral (i.e., black, pink, gold, and bamboo corals). Some species of precious corals prefer shallow (30 to 100 m [approximately 90 to 300 ft.]), nearshore habitat, while other species are known to grow in deeper waters (300 to 1,500 m [approximately 1,000 to 4,900 ft.]) farther from shore. Since World War II, no known harvests of precious corals have occurred in the CNMI EEZ (Western Pacific Regional Fishery Management Council 2009). In September 2008, NMFS issued a 5-year moratorium on harvesting gold corals (*Gerardia* spp., *Callogorgia gilberti, Narella* spp., *Calyptrophora* spp.) to protect against the threat of overharvesting (50 C.F.R. 665.469). On 29 May 2013, NMFS extended the moratorium through 30 June 2018 to encourage continued research on gold corals, which are long-lived and grow slowly, and, consequently, are vulnerable to overharvesting (78 Federal Register [FR] 32181). The NMFS has also proposed quotas for harvesting other species of precious corals (77 FR No. 1, Tuesday 3 January 2012). In Guam, a limit of 700 kg (1,543 lb.) of black coral can be harvested annually, and all other precious corals are limited to a combined total of 1,000 kg (2,205 lb.). In the CNMI, the limit on black corals is 2,100 kg (4,630 lb.) per year, and the limit on all other corals is 1,000 kg (2,205 lb.) (MacDuff and Roberto 2012).

Table 3.12-3: Commonwealth of the Northern Mariana Islands Commercial Fishery Landings

Year	Annual Total (lb.)	Value ($)
2005	432,790	$911,059
2006	536,724	$1,058,804
2007	510,680	$952,903
2008	388,426	$823,821
2009	331,506	$709,985
TOTAL	**1,868,620**	**$4,456,572**

Note: lb. = pound.

Sources: Divison of Fish and Wildlife and Western Pacific Fishery Information Network 2007, 2008, 2009, 2010, 2011

The CNMI bottomfish fishery gear for recreational and subsistence fishers include hand lines, home fabricated hand reels, and electric reels. Larger commercial vessels commonly use electric reels and hydraulics. There are no known commercial vessels with ice-making or freezer capabilities (Western Pacific Regional Fishery Management Council 2005). Trolling is the most common fishing method.

3.12.2.2.3 Transit Corridor

There is no data on commercial or recreational fishing within the transit corridor area because of the distance from land. Due to the distance from land and lack of rich fishing grounds within the corridor, there is limited to no commercial and recreational fishing activity within the transit corridor.

3.12.2.3 Subsistence Use

The U.S. Environmental Protection Agency (USEPA) considers subsistence fishers to be people who rely on noncommercial fish as a major source of protein. Subsistence fishers tend to consume noncommercial fish or shellfish at higher rates than other fishing populations, and for a greater percentage of the year, because of cultural or economic factors. There are very few studies in the United States that have focused specifically on subsistence fishers. The United States has issued no regulations to determine what or who would be considered a subsistence fisher. However, on 3 July 2013 a final rule proposed by the NMFS went into effect allowing non-commercial fishers who are residents of Guam or the CNMI to fish within the boundaries of the Marians Trench National Monument and to "exchange" their catch for goods and services (78 FR 32996). Within the terms of the final rule, an "exchange" is defined as,

> "[T]he non-market exchange of marine resources between fishermen and community residents for goods, and/or services for cultural, social, or religious reasons, and which may include cost recovery through monetary reimbursements and other means for actual trip expenses (ice, bait, food, or fuel) that may be necessary to participate in fisheries in the western Pacific."

Concerns over potential abuse of the non-market exchange leading to commercial market sales and competition for commercial fishers has been voiced by Global Ocean Legacy and Pew Charitable Trusts (The Samoa News 2013).

In addition, in the United States, there are no particular criteria or thresholds (such as income level or frequency of fishing) that definitively describe subsistence fishers. The USEPA issued guidance to state that at least 10 percent of licensed fishers in any area will be subsistence fishers (U.S. Environmental Protection Agency 2002). Because the 10 percent estimate is not based on actual subsistence fishing data, the number may be an overestimate or underestimate.

Subsistence fishing is an important part of the cultural and historical identity of Guam's indigenous peoples and Asian immigrant communities. Lower income communities are also more likely to engage in subsistence fishing (Allen and Bartram 2008; Office of Environmental Health Hazard Assessment 1997). An important part of the cultural heritage of local communities practicing subsistence fishing is sharing the catch. An estimated 96 percent of fishers share their catch with immediate family and close friends. Fifty-three percent of fishers do not typically share their catch outside of this close social circle, with the notable exception of contributing to church functions (e.g., fiestas) (Allen and Bartram 2008).

The fishing gear and larger vessels needed for offshore fishing are considerably more expensive than the smaller boats and fishing gear appropriate for nearshore fishing. Low-income populations would have limited means and opportunity to travel offshore into federal waters for fishing. Thus, it is assumed that the majority of subsistence fishing would occur in waters close to the coastline. Traditional fishing customs are also associated with fishing on nearshore reefs. Inshore fishing usually occurs within sight of the shoreline in bays, flats, and marshes or under piers, bridges, or near the jetties (Allen and Bartram 2008; Orange Beach Fishing Charters 2011). The water is usually less than 100 ft. (30 m) deep.

3.12.2.3.1 Guam

Most shallow water fishing out to 3 miles (mi.) (4.8 kilometers [km]) from shore is recreational and subsistence fishing typically conducted by vessels less than 25 ft. (7.6 m) long. Crustacean harvest occurs in inshore territorial waters also for recreational and subsistence purposes. The native Chamorros fish for a combination of recreational, subsistence, and cultural purposes. Sales of fish may occur to cover expenses, but the primary purpose is subsistence and cultural activities that include donations to assist each other and celebration of life events. A high value is placed on sharing one's fish catch with relatives and friends. The social obligation to share one's fish catch extends to part-time and full-time commercial fishers (Amesbury and Hunter-Anderson 1989). In 2005, Guam households purchased 51 percent of the fish consumed at a store or restaurant, approximately 24 percent was caught by a family member, 14 percent was caught by a family friend or extended family member, and 9 percent was purchased at a flea market or from a roadside stand (van Beukering et al. 2007). Domestic fishing on Guam supplements family subsistence, which is not just limited to fishing but is a combination of small-scale gardening, ranching, and wage work as well (Allen and Bartram 2008; Amesbury and Hunter-Anderson 1989).

3.12.2.3.2 Commonwealth of the Northern Mariana Islands

Both the CNMI and Guam are categorized as "fishing communities" by the Western Pacific Regional Fishery Management Council. This designation is given due to considerations such as the portion of the population that is dependent upon fishing for subsistence, the economic importance of fishery resources to the islands, and the geographic, demographic, and cultural attributes of the communities (Western Pacific Regional Fishery Management Council 2009). Recreational and subsistence fishing activities on CNMI primarily occur in the shallow water (< 500 ft. [< 152 m]) and are limited to daylight hours within a 30 mi. (48.2 km) radius of Saipan. These limitations are associated with the distances to nearby ports and the typical size of the vessels (usually less than 24 ft. [7.3 m] in length) (Western Pacific Regional Fishery Management Council 2005). This type of fishing is conducted without fathometers or nautical charts as the fishers rely on land features for guidance to a fishing area (Pacific Islands Fisheries Science Center 2011). In 2005, Division of Fish and Wildlife reported 150 vessels were being used for subsistence fishing (Western Pacific Regional Fishery Management Council 2005).

The lobster harvest occurs exclusively within 3 nm from shore. This harvest is for personal consumption, and volume is not reported. There is no information available regarding the subsistence or recreational harvest of coral reef resources inshore; however, a survey program is being established. Saipan Lagoon is thought to be heavily harvested by subsistence and recreational fishers; however, coral reefs are not believed to be used with any frequency by subsistence or recreational fishers. Poaching by foreign boats is believed to occur on coral reefs (Western Pacific Regional Fishery Management Council 2005).

3.12.2.3.3 Transit Corridor

It is assumed that there is limited to no subsistence fishing activity within the transit corridor because of the distance from land to the transit corridor and because the majority of subsistence use occurs nearshore.

3.12.2.4 Tourism

Coastal tourism and recreation can be defined as the full range of tourism, leisure, and recreationally oriented activities that take place in the coastal zone and the offshore coastal waters. These activities include coastal tourism development (e.g., hotels, resorts, restaurants, food industry, vacation homes, second homes, etc.), and the infrastructure supporting coastal development (e.g., retail businesses, marinas, fishing tackle stores, dive shops, fishing piers, recreational boating harbors, beaches, recreational fishing facilities, etc.). Also included is ecotourism and recreational activities such as recreational boating, cruises, swimming, recreational fishing, snorkeling and diving (National Oceanic and Atmospheric Administration 1998).

3.12.2.4.1 Guam

Visitors to Guam enjoy clear waters with excellent visibility extending out as far as 150 ft. (46 m), depending on the season. Diving and snorkeling are popular activities that may also include underwater photography, spear fishing, and exploring wrecks and reefs. Jet skiing, wind surfing, sea kayaking, water tours, dolphin watching, and submarine and semisubmersible tours are also available to tourists (and locals) on Guam.

In 2003, according to the Guam Economic Development Authority, the major revenue sources in Guam were tourism (60 percent), military and federal spending (30 percent), and "other" revenue (10 percent) (Guam Economic Development Authority 2008). In 2010, Guam welcomed approximately 1.2 million visitors. Japan accounted for approximately 76 percent of Guam's visitors, people traveling from Korea accounted for 10 percent, the United States accounted for 5 percent, and the smaller markets of Hong Kong, China, Australia, the Philippines, Micronesia, and Russia made up approximately 5 percent of visitors (Guam Visitors Bureau 2010). In 2006, Guam supported an estimated 20,000 tourism related jobs, approximately 35 percent of the total number of jobs available on the island (Allen and Bartram 2008).

Tumon Bay, halfway between Apra Harbor and the northern part of the island, is the premier resort destination on Guam. Luxury hotels line the beachfront with access to white sand and crystal clear, warm waters ideal for swimming and snorkeling. A few hotels are also located in the southern and central parts of the island.

Guam's warm waters offer dives for all skill levels with numerous opportunities for the uncertified diver as well as the most skilled. Diving is available from either a boat or the shore. Guam boasts that it is the only site in the world that has shipwrecks from both World War I and World War II, from two different countries, which can be visited at the same time: the Tokai Maru and the SMS Cormoran (Guam Visitors Bureau 2006). Figure 3.12-8 shows many of the popular dive sites in the MITT Study Area.

3.12.2.4.2 Commonwealth of the Northern Mariana Islands

The CNMI is a 14-island chain that features the three main islands of Saipan, Tinian, and Rota. With an average temperature of 84 degrees Fahrenheit (°F) and average humidity of 79 percent, these islands offer an attractive climate for a variety of tourism activities including sky diving, jungle tours, venues that offer dances of the Pacific Islanders, resort stays, golf, scuba diving (including historic ship and aircraft wrecks), touring historic sites, music, arts and crafts, Eurobungy trampoline, climbing walls, and gambling. With the ocean temperature averaging 82°F, other tourist activities include snorkeling, parasailing, water skiing, submarine tours, and sea walker tours (a 3 m [10 ft.]) dive for the non-scuba-certified tourist), banana boat rides (a non-motorized boat pulled by a motor boat), bird watching, deep sea fishing, flora and fauna tours, glass bottom boats, and cultural festivals featuring native food, arts, and crafts.

Tourism is the largest industry in the CNMI. There have been serious declines in tourism due to the Asian financial crisis, Severe Acute Respiratory Syndrome, and the 9/11 attacks on the United States (Cohen 2006). Between 1988 and 1996, the tourism industry grew by 15 percent annually. After a sharp decline in 1997 and 1998, a modest recovery had begun before the 11 September 2001 terrorist attacks. After the 2001 attacks, the tourism trade declined by 1.4 percent (Pacific Business Center Program – University of Hawaii 2008). Tourism continues to face economic difficulties, including increased labor costs associated with the $2 per hour increase in the CNMI minimum wage standards (from $3.05 an hour in 2007 to $5.05 an hour in 2010), with proposed subsequent wage increases of $0.50 a year until the CNMI reaches the federal minimum wage standards of $7.25 an hour (Eugenio 2010). The result is a short-term imbalance in the economy caused by the increased operating costs in the tourism industry and exacerbated by lagging tourist numbers. The withdrawal of Japan Air Lines from scheduled flights between Japan and Saipan reduced the CNMI Japanese tourist population from 40 percent of the total tourism to 29 percent in 2005 (Cohen 2006). In July 2011, the Marianas Visitors Authority reported 27,203 visitors traveled to the CNMI, which is down by 23 percent compared with the total for July 2010 (Tenorio 2011). Visitor arrivals from Japan continue to fall, with a 17 percent decrease in fiscal year

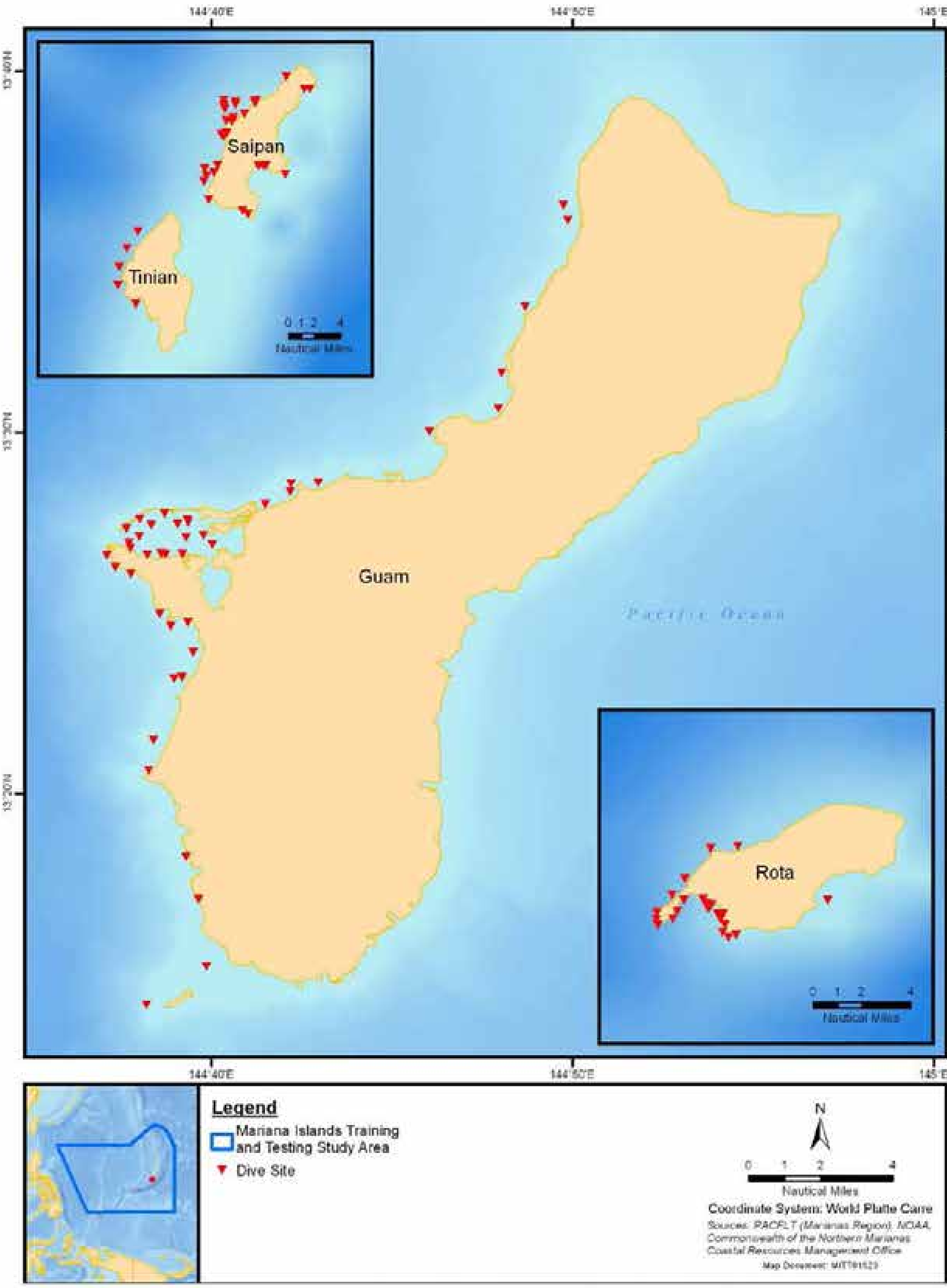


Figure 3.12-8: Popular Dive Sites Within the Mariana Islands Training and Testing Study Area

2011, and there has been no growth in the Korean tourism market from 2010 to 2011 because of reductions in direct flights by airlines in Japan and Korea. However, the CNMI has seen an increase in tourism from secondary markets. While Japanese and Korean tourism has decreased or remained flat, Chinese tourism has increased by 9 percent over 2010 totals, and Russian tourism is up by 19 percent compared with 2010. In addition, with direct flights from Hong Kong, the CNMI has experienced a 9 percent increase in visitors from Hong Kong between July 2010 and July 2011 (Tenorio 2011).

The island of Tinian has a total land area of approximately 39 square miles (mi.^{2}) (101.01 square kilometers [km^2]), but only about 13 mi.^{2} (33.7 km^2) of the island is outside the DoD-leased lands. Local government and the accommodation (e.g., hotel) industry are the island's largest employers (U.S. Department of the Navy 2010b). Tinian is the only populated island in the Mariana Islands that has not experienced dramatic economic development over the last 15 years. Most retail establishments are located in San Jose, and include a large hotel and casino, nightclubs, convenience stores, gas stations, small restaurants, bakeries, and banks (National Park Service 2001). The accommodations industry, including the Tinian Dynasty Casino Hotel, employs approximately 670 people, or about 40 percent of the island's total employed population. Local government has approximately 270 employees, or about 17 percent of the total employed, and the education industry employs approximately 130 people, which is about 8 percent of the total number of employed people. In 2008, Tinian's unemployment rate was approximately 17 percent (U.S. Department of the Navy 2010b). Although gambling is the most profitable tourist attraction, the World War II historic sites and wildlife viewing also attract tourists to the island and encourage longer stays. Most of the historic sites are located within the exclusive military use area.

The island of Rota is the smallest of the three major islands in the CNMI with a land area of approximately 33 mi.^{2} (85.5 km^2). The island primarily offers outdoor recreation and sightseeing, including a famous swimming hole on the western side of the island, a limestone quarry used by ancient Chamorros, and a seabird sanctuary providing habitat for thousands of seabirds.

3.12.2.4.3 Transit Corridor

It is assumed that there is limited to no tourism activity within the transit corridor because of the distance from land to the transit corridor and because the majority of tourism activity occurs nearshore.

3.12.3 Environmental Consequences

This section presents the analysis of potential impacts on socioeconomic resources, from implementation of the project alternatives, including the No Action Alternative, Alternative 1, and Alternative 2. In the sections below, each socioeconomic resource stressor (i.e., an external stimulus or multiple stimuli that causes stress to a resource) is introduced, analyzed by alternative, and analyzed for training and testing activities.

Potential impacts to socioeconomic resources are not analyzed beyond 12 nm from shore, because EO 12114, which establishes environmental policy beyond 12 nm, does not apply to socioeconomics. Table F-3 in Appendix F (Training and Testing Activities Matrices) shows the warfare areas and associated stressors that were considered for analysis of socioeconomic resources.

The stressors vary in intensity, frequency, duration, and location within the MITT Study Area. The stressors applicable to socioeconomic resources in the MITT Study Area and analyzed below include the following:

- Accessibility (limiting access to the ocean and the air)
- Airborne acoustics (weapons firing, aircraft, and vessel noise)
- Physical disturbance and strike (aircraft, vessels and in-water devices, military expended materials)
- Secondary

Secondary stressors resulting in indirect impacts to socioeconomic resources are discussed in Section 3.12.3.4 (Secondary Impacts from Availability of Resources). A secondary stressor, as used in this section, is a stressor that has the potential to affect a socioeconomic resource as a result of a direct effect on another non-socioeconomic resource. For example, if a training activity has the potential to affect certain species of fish, and those species also constituted an economically important fishery, then the effect of the stressor on those fish species could have an indirect, or secondary, effect on the socioeconomic resource of recreational fishing.

Analysis of economic impacts evaluates the impacts of the alternatives on the economy of the region of influence, while analysis of social impacts considers the change to human populations and how the action alters the way individuals live, work, play, relate to one another, and function as members of society. Because the proposed training and testing activities take place predominantly offshore, socioeconomic impacts would be associated with economic activity, employment, income, and social conditions (i.e., livelihoods) of industries or operations that use the ocean resources within the MITT Study Area. Although there are no permanent population centers in the region of influence and the typical socioeconomic considerations such as population, housing, and employment are not applicable, this section will analyze the potential for fiscal impacts on marine-based activities and coastal communities. When considering impacts on recreational activities such as fishing, boating, and tourism, both the economic impact associated with revenue from recreational tourism and public enjoyment of recreational activities is considered.

The proposed training and testing activities were evaluated to identify specific components that could act as stressors by having direct or indirect effects on the resources of commercial transportation and shipping, commercial and recreational fishing, subsistence use, and tourism. For each of the three stressors listed above, a discussion of impacts on the relevant resources is included for each alternative. All five resources are not affected by each of the three stressors. For example, the resource of air traffic is not impacted by the stressors of physical disturbance and strike. Potential impacts to air traffic are addressed under the accessibility stressor.

3.12.3.1 Accessibility (to the Ocean and Airspace)

Military training and testing activities have the potential to temporarily limit access to areas of the ocean for a variety of human activities associated with commercial transportation and shipping, commercial recreation and fishing, subsistence use, and tourism in the MITT Study Area.

Danger zones and restricted areas located within 12 nm from shore in the MITT Study Area are well established and clearly marked on navigational charts used by commercial and recreational vessels. These areas do limit access to fishing grounds potentially of interest to commercial, recreational, and subsistence fishers and to dive sites that may be of interest to residents and tourists.

When training or testing activities are scheduled that require specific areas to be free of non-participating vessels to ensure public safety, the military requests that the U.S. Coast Guard broadcasts NOTMARs on its Radio Channel 16, via Rescue 21, or on U.S. Navy radio stations. They request that the FAA issue NOTAMs, depending on the activity, to warn the public of upcoming military activities. The military may also issue a navigational warning (HYDROPAC) to warn the public of a navigational danger, again, depending on the type of activity. Military training and testing areas and SUA are identified on nautical and aeronautical charts to inform surface vessels and aircraft that military activities occur in the area.

The restricted airspace, R-7201, overlays FDM and the waters surrounding the island out to a distance of 3 nm. Airspace R-7201A extends from 3 nm out to 12 nm measured from the center of FDM (Figure 3.12-2 and Figure 3.12-4). R-7201 and R-7201A support live-fire and inert engagements such as surface-to-ground and air-to-ground gunnery, bombing, and missile exercises, all of which require that access to the area be permanently restricted to ensure the safety of the public. Even when live-fire or other potentially hazardous activities are not occurring at FDM, the threat of unexploded ordnance is always present. No commercial or recreational activities occur or are permitted on or near the island, and aircraft and marine vessels are restricted from entering within 3 nm of FDM. Notices to Airmen and NOTMARs are issued at least 72 hours in advance of potentially hazardous training or testing activities. Notices to Airmen and NOTMARs may also advise restrictions out to 12 nm as needed for certain training or testing events to ensure better protection to the public and the military during some training and testing activities.

The 2013 Marianas Island Range Complex Airspace EA/OEA analyzed extending the proposed danger zone surrounding FDM from 10 nm to 12 nm (congruent with restricted airspace R-7201A). The analysis supports the establishment of the expanded Danger Zone under the authority of the U.S. Army Corps of Engineers (C.F.R., Title 33 Part 334) to restrict all private and commercial vessels from entering the area during hazardous training and testing activities. When no training or testing activities are scheduled, the waters within the 12 nm danger zone (but not the 3 nm danger zone) are accessible to the public.

The Mariana Islands Range Complex EIS/OEIS analyzed the impacts from establishing a small arms danger zone for the existing Finegayan Small Arms Range, located in nearshore waters off of the Naval Base Guam Telecommunications Site and extending seaward from Haputo Point.

In addition to issuing NOTAMs and NOTMARs to announce scheduled training and testing events, upcoming events are communicated to stakeholders (e.g., local mayors, resources agencies, and fishers) using a telephone tree and e-mail distribution developed by Joint Region Marianas with stakeholder input. Notices are also sent to the NOAA, local cable channels, and emergency management offices.

Establishing two new danger zones and modifying an existing danger zone is proposed under Alternatives 1 and 2 (see Chapter 2, Description of Proposed Action and Alternatives, Section 2.7 and Section 2.8).

- A danger zone would be established over nearshore waters, approximately 0.5 nm seaward of the Pati Point Combat Arms Training and Maintenance Range and Pati Point EOD Range, located at Pati Point on the northeastern tip of Guam, to support existing small arms training and explosives ordnance range activity.
- A danger zone would be established to support small arms training located west of Guam, beyond 3 nm from shore and within the territorial waters of Guam. The danger zone would be located within an existing Navy “Firing Danger Area” charted on NOAA Chart 81048, Guam. The area is currently used by Navy crews to conduct small arms training.

- The existing danger zone off Orote Point (33 C.F.R. Part 334.1420) would be would be modified to support .50 caliber sniper training.

Once established, restrictions associated with these zones would be codified in 33 C.F.R. 334, and activities occurring at these locations would be announced in advance through NOTMARs to reduce conflicts with recreational, commercial, and subsistence activities.

To ensure public safety, access to nearshore areas may be temporarily restricted during military training and testing activities within a proposed danger zone. During these times, mariners may be required to transit to their destination avoiding the danger zone. Potential impacts to mariners could include incurring additional fuel costs, expending more time in transit, or rescheduling a trip. The extent of the impact would mainly be dependent on the added length of the alternate route around the danger zone or exclusion zone. A vessel transiting west from Pati Point would need to divert seaward and remain approximately 0.5 nm from shore for a distance of approximately 1 nm. A vessel traveling at an average speed of 5 knots would add less than 20 minutes of transit time to navigate around the danger zone. This estimate assumes the vessel starts from shore on one side of the danger zone and comes to shore at the opposite side of the danger zone. A vessel remaining offshore would need even less time to avoid the danger zone. Although accessibility to waters within the proposed danger zones would be restricted during specified times, the restrictions are temporary, and the military will continue to notify the maritime community of scheduled closures. The vast majority of the MITT Study Area would remain accessible to the public.

Data are available on NOTMARs issued from 2010 through 2012 for FDM and W-517. An average of 39 NOTMARs were issued per year for FDM and 34 for W-517 warning vessels of military activities and temporarily restricting access to waters in these areas to ensure public safety (Table 3.12-4). Over the 3-year period, access to waters around FDM was restricted for an average of 159 days per year (access to waters within 3 nm of FDM is restricted at all times), and access to waters within W-517 was restricted for an average of 95 days per year. When issued, NOTMARs specify how long waters are restricted, which can range from a few hours to the entire day.

Table 3.12-4: Notices to Mariners Issued for Military Activities Occurring at Farallon de Medinilla and Warning Area-517 from 2010 through 2012

Year	Location	Number of NOTMARs Issued	Number of Days Affected
2010	FDM	32	107
	W-517	34	73
2011	FDM	42	170
	W-517	38	116
2012	FDM	44	201
	W-517	30	97
3-Year Average	**FDM**	**39**	**159**
	W-517	**34**	**95**

Notes: FDM = Farallon de Medinilla, NOTMAR = Notice to Mariners, W-517 = Warning Area-517

Specifically for FDM, data recorded from October to December 2011 show that NOTMARs issued for 14 days in October restricted access for an average of 11.3 hours per day. In November, NOTMARs were issued for 15 days, and on those days waters around FDM were restricted for an average of 7.4 hours.

NOTMARs were issued for 20 days in December, resulting in waters being restricted for an average of 16 hours per day; however, the December average is skewed because for 6 out of the 20 days the waters were restricted for the entire day (i.e., 24 hours). Excluding those 6 days, waters around FDM were restricted for an average of 12.6 hours per day.

The military has also requested that the U.S. Coast Guard issue NOTMARs to announce when plans to use an area change (e.g., W-517), and access to the area will no longer be restricted (as previously published) and will now be accessible. Actions like notifying mariners when plans change are intended to reduce potential impacts to accessibility and improve communication between the military and local communities.

A 2011 survey of small boat fishers on Guam attempted to assess the impacts of restricting access to waters within W-517 during military activities (Hospital and Beavers 2012). The fishers were asked if military activities ever affected their fishing trips. Of the 139 respondents, 54 percent reported that in the past 12 months at least one "pelagic fishing" trip was affected in some way by military activities, 42 percent reported that at least one "bottomfishing" trip had been affected, and 31 percent reported that military activities had affected one or more "reef fishing" trips. The data were organized by the type of fishing trip (i.e., pelagic fishing, bottomfishing, and reef fishing). The survey did not ask how the trips were affected by restricting access to W-517.

In response to the question, "In the past 12 months, what percent of your fishing trips were affected by military exercises?" respondents reported that an average of 17 percent of pelagic fishing trips had been affected in the 12 months, 14 percent of bottomfishing trips had been affected, and 10 percent of reef fishing trips had been affected, in some way, by military activities in the past 12 months (Hospital and Beavers 2012). Again, the survey did not ask how the fishing trips were affected.

The researchers speculated that potential effects could include increased travel costs to launch a vessel, increased search costs associated with not fishing in familiar and productive fishing grounds, a change in targeting methods to more fuel-intensive methods such as trolling, and inability to fish at all that day. Fishers were given an opportunity to provide comments as part of the survey, and although the survey indicates that temporarily restricting access to waters within W-517 can affect fishing activities, the comments mention military activities only twice. One commenter asked if an alternate location for "target practice" was available, and a miscellaneous comment listed "military interference" as a concern. Of the other 49 comments, the majority focused on marine protected areas, fish aggregating devices (needing more and replacing lost ones), the need for better infrastructure (e.g., boat ramps), and fishing regulations (Hospital and Beavers 2012).

In an effort to respond to local community concerns, the military has been exploring opportunities to limit necessary access restrictions only to portions of W-517 needed during certain military training activities (to ensure public safety, some activities would still necessitate restricting access to all of W-517). This would allow fisherman access to popular fishing areas while military training activities are being conducted elsewhere in W-517. If restricting access to only a portion of W-517 is feasible, a NOTMAR would be issued specifying the areas (latitudes) within W-517 that would be temporarily restricted due to the conduct of military training activities. The remaining areas of W-517 would be accessible to the public. This would allow areas within W-517 to be open to non-military vessels for fishing and transit to Galvez Bank, Santa Rosa Reef, and White Tuna Banks. Additionally, W-11, W-12, and W-13 provide the military with more flexibility to utilize areas other than W-517 for activities requiring exclusive use of airspace. All warning areas in the MITT Study Area overlie primarily deep ocean waters far from land and the nearshore waters that are most frequently used by the public.

The changes in accessibility to areas of the ocean would be an impact if it directly contributed to loss of income, revenue, or employment. Disturbance to human activities that result in impacts on payrolls, revenue, or employment is quantified by the amount of time the activity may be halted or the amount of time expended for the activity to be rerouted and the ability for the activity to take place in another location. Air Traffic Control Assigned Airspace and warning areas are restricted for short periods of time (typically on the order of hours) to cover the timeframes of training and testing activities. Airspace designated for military use (e.g., R-7201 and R-7201A) is identified on aeronautical charts, and the Navy posts NOTAMs when restrictions are in place to accommodate a training or testing activity. Prior to initiating a training or testing activity, the military would follow standard operating procedures to visually scan an area to ensure that non-participants are not present. If non-participants are present, the military delays, moves, or cancels its activity. Public accessibility is no longer restricted once the activity concludes.

Stressors to accessibility, that is restrictions to the availability of ocean space or air space, would be temporary, with the exception of access to C.F.R.-designated permanent danger zones. Mariners have a responsibility to be aware of conditions on the ocean, including when access to military warning areas and danger zones is restricted; however, it is not expected that direct conflicts in accessibility would frequently occur. The locations of restricted areas are published and available to mariners, who typically review such information before boating in any area. Restricted areas are typically avoided by experienced mariners. The military will continue to engage the public on issues associated with accessibility to the ocean and airspace within the MITT Study Area.

3.12.3.1.1 Socioeconomic Activities

3.12.3.1.1.1 Commercial Transportation and Shipping

The offshore and nearshore areas of the MITT Study Area include the established Mariana Island Range Complex used for military training and testing activities and a transit corridor extending to the east towards the United States. Commercial vessels entering the MITT Study Area, including established restricted areas and danger zones, operate under maritime regulations and are not limited by military activities. Potential disruptions to commercial shipping are limited or avoided by requesting that the U.S. Coast Guard issue NOTMARs. NOTMARs advise commercial ship operators, commercial fisherman, recreational boaters, and other users of the area that the military will be operating in a specific area, allowing them to plan their activities accordingly. Additionally, for certain activities the Navy Hydrographic office will issue HYDROPACs prior to an activity. These temporary limitations on access are established and implemented for the safety of the public and have been employed regularly over time without significant socioeconomic impacts on commercial shipping activities.

Air Traffic Control Assigned Airspace is activated for short periods of time (typically on the order of hours) to cover the timeframes of training and testing activities. Warning areas and other SUA (e.g., W-517 south of Guam) are established for military use and are identified on aeronautical charts (see Figure 3.12-2 and Figure 3.12-4). The Navy posts NOTAMs when restrictions are in place to accommodate training or testing activity. Air traffic routes for commercial and general aviation flights departing and arriving at Guam International Air Terminal, the only commercial or civilian airport on Guam, are established such that overlap with military aircraft activities would be avoided.

Military air traffic in the CNMI takes place in airspace over the island of Tinian. Tinian's North Field has four runways, taxiways, and parking aprons providing various tactical scenarios without interfering with commercial and community activities south of the military lease area. However, North Field is in need of improvements before it can be fully utilized for training activities. Saipan International Airport is the largest commercial airport in the CNMI, and is the main gateway for commercial air traffic into the CNMI (Commonwealth Ports Authority 2005). Direct flights are available from major cities in Japan, Korea, China, and Guam. A commuter terminal services Tinian and Rota islands.

The Navy coordinates use of ATCAA with the Guam FAA and the FAA for international routes beyond the region. The coordinated effort has and will continue to maintain safe separation of military activities from commercial and general aviation flights and to limit times when airspace is temporarily inaccessible.

3.12.3.1.1.2 Commercial and Recreational Fishing

Commercial and recreational fishing activities contribute to the overall economy and cultural heritage in the CNMI and on Guam. The military has conducted training and testing activities within this region in the past and has not barred fishing or recreational uses, except in select nearshore areas, as described above, where the military has published rules in place through the U.S. Army Corps of Engineers and U.S. Coast Guard. With the exception of these designated areas where published federal rules are in place, commercial and recreational interests such as fishing, boating, and beach use are not restricted. Public access to surrounding areas is not limited.

Training or testing activities requiring a temporary safety zone to prevent non-participating vessels from entering a potentially dangerous area, such as during an activity using explosives, would not significantly affect commercial and recreational fishing activities, because the zone would be enforced only for a brief period (hours) while the activity takes place. Typically, a zone extends over a circular area with a radius of a couple of miles (depending on the activity). Commercial and recreational fishing activities could occur in the area before and after the temporary restriction. Should the military find non-participants present in a temporary safety zone, the military would halt or delay (and reschedule, if necessary) all potentially hazardous activity until the non-participants have exited the safety zone (Section 3.13, Public Health and Safety).

The public is notified via NOTMARs and HYDROPACs of upcoming activities requiring a temporary safety zone. These measures provide mariners with advance notice of areas being used by the military for hazardous training and testing activities, and allow mariners to plan accordingly by selecting an alternate destination without appreciable effect to their activities. Furthermore, the military makes every effort to avoid conducting activities requiring a temporary safety zone in areas where non-participating vessels are present or are likely to be present.

The NOTMARs and HYDROPACs are intended to prevent fishers from expending time and fuel resources transiting to a temporarily closed location. Effective and efficient communication will enable fishers to be better informed of military activities, and will reduce the number of unanticipated scheduling conflicts between fishing activities and military activities. A recent survey conducted by the Navy of fishers who use waters in the Southern California Range Complex off of California resulted in several recommendations that the Navy is or has implemented and would implement within the Marianas Islands Range Complex, including, (1) regular and up to date broadcasts of scheduled closures on Very High Frequency radio, (2) frequent updates to websites on upcoming ranges closures, (3) establishing a single Navy point of contact with the most up to date information on closures for fishers without website access, and (4) specifying whether a scheduled Navy activity requires a complete closure or if fishing can occur simultaneously with the Navy activity (Naval Undersea Warfare Center 2009). The military's intent is to maintain efficient and effective communication with fishers and other non-participants preceding and during military training and testing activities.

Upon completion of training or testing activities, restriction on certain areas (e.g., Apra Harbor small arms firing range) are lifted and fishers would be able to return to fish and transit through the area. To help manage competing demands and maintain public access in the MITT Study Area, the military conducts its offshore operations in a manner that minimizes restrictions to commercial fisherman. Navy ships, fishers, and recreational users operate within the area together, and keep a safe distance between each other. Navy and other military participants would relocate as necessary to avoid conflicts with non-participants (U.S. Department of the Navy 2007). Only specific areas within MITT Study Area have been designated as danger zones or restricted areas (see Figure 3.12-2, Figure 3.12-4, and Figure 3.12-6). When a temporary safety zone is established, temporarily limiting commercial and recreational fishing in that specific area, other areas in the MITT Study Area would remain open to commercial and recreational fishing. Fish aggregating devices have been deployed around Guam outside of military warning areas and restricted areas to create alternate fishing sites that are not subject to limitations on accessibility associated with military training and testing activities (Chapter 2, Description of Proposed Action and Alternatives, Figure 2.7-1).

As described in Section 3.12.3.1 (Accessibility [to the Ocean and Airspace]), NOTMARs have been issued for R-7201, surrounding FDM, and W-517 temporarily restricting access to these areas. An average of 39 NOTMARs were issued per year for FDM and 34 for W-517 to ensure public safety (Table 3.12-4). Over a 3-year period from 2010 through 2012, access to waters around FDM was restricted for an average of 159 days per year (access to waters within 3 nm of FDM is restricted at all times), and access to waters within W-517 was restricted for an average of 95 days per year (Table 3.12-4). When issued, NOTMARs specify how long waters are restricted, which can range from a few hours to the entire day.

The military has been conducting training and testing activities within the MITT Study Area for decades, and has taken and will continue to take measures to prevent interruption of commercial and recreational fishing activities. The military does not limit fishing activities from occurring in areas of the MITT Study Area that are not being used for training and testing activities. To minimize potential military/civilian interactions, the Navy will continue to publish scheduled operation times and locations on publicly accessible Navy websites and through U.S. Coast Guard issued NOTMARs up to 6 months in advance of planned events. When feasible, the military will use these same means of communication to notify the public of changes to previously published restrictions. These efforts are intended to ensure that commercial and recreational users are aware of the military's plans and allow commercial and recreational users to plan their activities to avoid scheduled training and testing activities. Advanced planning on behalf of the military and effective communication of the military's plans should minimize limits on accessibility to desirable fishing locations and, consequently, have only a minor effect on commercial and recreational fishing activities. The Navy will continue to engage with the public and the local fisherman on issues affecting commercial and recreational fishing in order to limit potential impacts associated with military activities.

3.12.3.1.1.3 Subsistence Use

Subsistence uses typically occur from the shore or from small vessels within 3 nm or closer to shore. The majority of military training and testing activities occur in offshore waters (beyond 3 nm and in many cases beyond 12 nm) where subsistence fishing typically does not occur. Some training activities are proposed in nearshore areas of Apra Harbor on Guam, on selected beaches on Tinian (for Amphibious Warfare activities), Rota (e.g., Rota airport), and Saipan. With the notable exception of Naval Special Warfare training activities, most activities occurring in nearshore waters take place approximately five times per year (see Chapter 2, Description of Proposed Action and Alternatives). The number of Naval Special Warfare activities and "Other Activities" proposed to occur in nearshore waters of Guam and the CNMI varies widely from 3 to 100 times per year. Nevertheless, no impacts on subsistence activities (e.g., fishing) from conducting the proposed training and testing activities in the MITT Study Area are anticipated, because only those federally designated areas would be restricted from public access.

3.12.3.1.1.4 Tourism

Tourism activities make an appreciable contribution to the overall economy within the MITT Study Area. The establishment of temporary exclusion zones, for safety purposes, has the potential to adversely affect some tourism activities. For example, a visitor who is in the CNMI for only a few days may not be able to reschedule an activity if the establishment of an exclusion zone conflicts with the activity and no alternate site for the activity is suitable. An occurrence of this type is anticipated to be low, because displacement would be brief (hours), and the temporary exclusion zones are created in areas where tourism activities do not typically occur. The military temporarily limits public access only to areas where there is a risk of injury or property damage and publishes scheduled activities through the use of NOTMARs and NOTAMs. The military strives to conduct its operations in a manner that is compatible with tourism by minimizing temporary access restrictions. Published notices allow recreational users to adjust their routes to avoid danger zones and temporary safety zones. If civilian vessels are located within a danger zone or temporary safety zone at the time of a scheduled testing or training activity, the military would suspend operations until the area is cleared of non-participating vessels. Operations would only continue where and when it is safe and possible to avoid the non-participating vessels. If avoidance is not safe or possible, the military activity would be halted and may relocate or be delayed. In some instances where safety requires exclusive use of a specific area, non-participants in the area are asked to relocate to a safer area for the duration of the military activity.

The military may request that the U.S. Coast Guard or U.S. Army Corps of Engineers enforce restrictions to public access at the designated areas in Apra Harbor, which prohibit public access during certain times (33 C.F.R. 334 and 33 C.F.R. 165).

In addition, the 12 nm Danger Zone surrounding FDM Island restricts all commercial and recreational vessels from approaching the island without permission from the Navy. The island serves as a bombing range for both explosive and non-explosive munitions training and testing. No tourism activities occur on or in the vicinity of the island for safety reasons.

3.12.3.1.2 No Action Alternative

3.12.3.1.2.1 Training Activities

Under the No Action Alternative, potential accessibility impacts to socioeconomic activities would be associated primarily with anti-air warfare, anti-surface warfare, anti-submarine warfare, mine warfare, amphibious warfare, and naval special warfare activities. Training activities would continue at current levels and within established ranges and training locations. There would be no anticipated impacts on commercial transportation and shipping, commercial and recreational fishing, subsistence use, or tourism, because inaccessibility to areas of co-use would be temporary and of short duration (hours). Based on the military standard operating procedures and the large expanse of the MITT Study Area that would be available to the public, accessibility impacts would remain negligible.

The military will continue to collaborate with local communities to enhance existing means of communications with the aim of reducing the potential effects of limiting access to areas designated for use by the military.

3.12.3.1.2.2 Testing Activities

Only one testing activity occurs under the No Action Alternative, the North Pacific Acoustic Lab Philippine Sea 2018–19 Experiment (Deep Water), as shown in Chapter 2 (Description of Proposed Action and Alternatives, Table 2.8-4). No impacts to accessibility are anticipated from this testing activity because it takes place in deep, offshore waters.

3.12.3.1.3 Alternative 1

3.12.3.1.3.1 Training Activities

Training activities and associated stressor components as described under the No Action Alternative would continue and would increase over the No Action Alternative. There would be no changes to the military's current standard operating procedures defining safety precautions and actions taken by the military to protect the public during hazardous training activities on the ocean. Under Alternative 1, potential impacts affecting accessibility to areas of the MITT Study Area would be the same as those associated with the No Action Alternative. Despite the increase in tempo of training activities and the expansion of the MITT Study Area, no impacts from Alternative 1 activities on commercial transportation and shipping, commercial and recreational fishing, subsistence use, or tourism are anticipated, because training activities would place only temporary and short duration (hours) restrictions on public use of scheduled training areas. Based on the military's standard operating procedures and the large expanse of the MITT Study Area that would be available to the public, accessibility impacts would remain negligible.

3.12.3.1.3.2 Testing Activities

Under Alternative 1, testing activities and associated stressor components would increase over the No Action Alternative. The impact on accessibility would be negligible for the same reasons stated for training activities above. In addition, far fewer testing than training activities are proposed (see Chapter 2, Description of Proposed Action and Alternatives, Tables 2.8-2 to 2.8-4).

3.12.3.1.4 Alternative 2

3.12.3.1.4.1 Training Activities

Training activities and associated stressor components would continue and would increase over the No Action Alternative and Alternative 1. There would be no changes to the military's current standard operating procedures defining safety precautions and actions taken by the military to protect the public during hazardous training activities on the ocean. Despite the increase in tempo of training activities, no impacts from Alternative 2 activities on commercial transportation and shipping, commercial and recreational fishing, subsistence use, or tourism are anticipated, because training activities would place only temporary and short duration (hours) restrictions on public use of scheduled training areas. Furthermore, with the exception of the designated danger zones and restricted areas where non-participants are prohibited during training and testing activities, the military would halt, delay, or move any potentially hazardous activity in the event non-participants entered a temporary safety zone. Based on the military's standard operating procedures and the large expanse of the MITT Study Area that would be available to the public, accessibility impacts would remain negligible.

3.12.3.1.4.2 Testing Activities

Under Alternative 2, testing activities and associated stressor components would increase over the No Action Alternative and Alternative 1. The impact on accessibility would be negligible for the same reasons stated for training activities above. In addition, far fewer testing than training activities are proposed (see Chapter 2, Description of Proposed Action and Alternatives, Tables 2.8-2 to 2.8-4).

3.12.3.2 Airborne Acoustics

As an environmental stressor, loud noises, sonic booms, and vibrations generated from military training and testing activities such as weapons firing, in-air explosions, and aircraft transiting have the potential to disrupt wildlife and humans in the MITT Study Area.

3.12.3.2.1 Socioeconomic Activities

3.12.3.2.1.1 Tourism and Recreational Activities

Noise interference could decrease public enjoyment of recreational activities. These effects would occur on a temporary basis, only when weapons firing, in-air explosions, and aircraft transiting occur. Of these activities, military training and testing activities involving weapons firing and in-air explosions would only occur when the military can confirm the area is clear of non-participants, reducing the likelihood that noise from these activities would disturb tourists. Most naval training would occur well out to sea, while tourism and civilian recreational activities are largely conducted within a few miles of shore. Tourism and recreational activity revenue is not expected to be impacted by airborne noise.

3.12.3.2.2 No Action Alternative

3.12.3.2.2.1 Training Activities

Under the No Action Alternative, potential airborne noise impacts would be associated primarily with anti-air warfare, anti-surface warfare, anti-submarine warfare, mine warfare, and amphibious warfare. Training activities would continue at current levels and within established ranges and training locations. There would be no anticipated impacts on tourism because (1) most military training occurs well out to sea, while most tourism and recreational activities occur near shore; and (2) military training activities producing airborne noise are normally short term and temporary. Therefore, airborne noise impacts on tourism would be negligible.

3.12.3.2.2.2 Testing Activities

Only one testing activity occurs under the No Action Alternative, the North Pacific Acoustic Lab Philippine Sea 2018–19 Experiment (Deep Water), as shown in Chapter 2 (Description of Proposed Action and Alternatives, Table 2.8-4). No impacts to tourism from airborne acoustics would occur from this testing activity, because no aircraft or other airborne platforms would be used.

3.12.3.2.3 Alternative 1

3.12.3.2.3.1 Training Activities

Under Alternative 1, potential airborne noise would be the same as that associated with the No Action Alternative. Training activities and associated stressor components would continue and would increase over the No Action Alternative. Similar to the No Action Alternative and despite the increase in tempo, there would be no anticipated impacts on tourism because (1) most military training occurs well out to sea, while most tourism and recreational activities occur near shore; and (2) military training activities producing airborne noise are normally short term and temporary. Therefore, airborne noise impacts on tourism would be negligible.

3.12.3.2.3.2 Testing Activities

Under Alternative 1, testing activities and associated stressor components would increase over the No Action Alternative. Impacts associated with airborne acoustics would be negligible for the same reasons stated for training activities above. In addition, far fewer testing than training activities are proposed (see Chapter 2, Description of Proposed Action and Alternatives, Tables 2.8-2 to 2.8-4).

3.12.3.2.4 Alternative 2

3.12.3.2.4.1 Training Activities

Under Alternative 2, potential airborne noise would be the same as that associated with the No Action Alternative. Training activities would continue but with an increase in tempo within the MITT Study Area. Similar to Alternative 1, there would be no anticipated impacts on tourism because (1) most military training occurs well out to sea, while most tourism and recreational activities occur near shore; and (2) military training activities producing airborne noise are normally short term and temporary. Therefore, airborne noise impacts on tourism would be negligible.

3.12.3.2.4.2 Testing Activities

Under Alternative 2, testing activities and associated stressor components would increase over the No Action Alternative and Alternative 1. Impacts associated with airborne acoustics would be negligible for the same reasons stated for training activities above. In addition, far fewer testing than training activities are proposed (see Chapter 2, Description of Proposed Action and Alternatives, Tables 2.8-2 to 2.8-4).

3.12.3.3 Physical Disturbance and Strike Stressors

The evaluation of impacts on socioeconomic resources from physical disturbance and strike stressors focuses on direct physical encounters or collisions with objects moving through the water or air (e.g., vessels, aircraft, unmanned devices, and towed devices), dropped or fired into the water (non-explosive practice munitions, other military expended materials, and ocean bottom deployed devices), or resting on the ocean floor (anchors, mines, targets) that may damage or encounter civilian equipment. Physical disturbances that damage equipment and infrastructure could disrupt the collection and transport of products, which may impact industry revenue or operating costs.

Though highly unlikely, it is possible that military training and testing equipment and vessels moving through the water could collide with non-military vessels and equipment. Most of the training and testing activities involve vessel movement and use of towed devices. However, the likelihood that a military vessel would collide with a non-military vessel is remote because of the prevalent use of navigational aids or buoys separating vessel traffic, shipboard lookouts, radar, and marine band radio communications by both military and civilians. Therefore, the potential to impact commercial transportation and shipping by physical disturbance and strike stressors is negligible and requires no further analysis.

Aircraft conducting training or testing activities in the MITT Study Area operate in designated military special use airspace (e.g., warning areas). All aircraft, military and civilian, are subject to FAA regulations, which define permissible uses of designated airspace, and are implemented to control those uses. These regulations are intended to accommodate the various categories of aviation, whether military, commercial, or general aviation. By adhering to these regulations, the likelihood of civilian aircraft coming into contact with military aircraft is remote. In addition, military aircraft follow procedures outlined in air operations manuals, which are specific to a warning area or other special use airspace, and which describe procedures for operating safely when civilian aircraft are in the vicinity.

Military expended materials can physically interact with civilian equipment and infrastructure. Almost all training and testing activities produce military expended materials such as chaff, flares, projectiles, casings, target fragments, missile fragments, rocket fragments, and ballast weights. The vast majority of these expended materials sink to the sea floor after use, and in most cases are used in deep waters located 3 nm from shore and beyond. Training and testing activities occurring in nearshore waters most often use simulated rounds or do not use ordnance (see Chapter 2, Description of Proposed Action and Alternatives, for details).

3.12.3.3.1 Socioeconomic Activities

3.12.3.3.1.1 Commercial and Recreational Fishing/Subsistence Use

The majority of commercial and recreational fishing in the MITT Study Area takes place in nearshore waters (less than 3 nm from shore), where the military conducts limited training and testing activities. Therefore, most recreational fishing would occur away from physical disturbance and strike stressors associated with training and testing activities. Some commercial and recreational fishing occurs beyond 3 nm in areas where the military trains and tests and could be indirectly affected by the proposed activities if physical disturbance and strike stressors were to disrupt fisheries in those areas to such an extent that commercial fishers would no longer be able to find their target species. As described in Section 3.9.3 (Environmental Consequences), the behavioral responses that could occur from various types of physical stressors associated with training and testing activities would not compromise the general health or condition of fish and, therefore, would not result in associated impacts to commercial or recreational fishing resources.

Commercial fishing activities have the potential to interact with equipment placed in the ocean or on the ocean floor for use during proposed military training and testing activities. This equipment could include ship anchors, moored or bottom mounted targets, mines and mine shapes, tripods, and use of towed system and attachment cables. Many different types of commercial fishing gear are used in the MITT Study Area, including gillnets, longline gear, troll gear, trawls, seines, and traps or pots. Commercial bottom fishing activities that use these types of gear have a greater potential to be affected by interaction with military training and testing equipment, resulting in the loss of or damage to both the military equipment and the commercial fishing gear. The military recovers many of the targets (e.g., mines and mine shapes) and target fragments used in training and testing activities, and would continue to do so to minimize the potential for interaction with fishing gear and fishing vessels (as well as other vessels). Unrecoverable items are typically small, constructed of soft materials (such as target cardboard boxes or tethered target balloons), or are intentionally designed to sink to the bottom after serving their purpose (such as expended 55-gallon steel drums), so that they would not represent a collision risk to vessels, including commercial fishing vessels.

3.12.3.3.1.2 Tourism

While military training and testing activities can occur throughout the MITT Study Area, most (especially hazardous) activities occur well out to sea. The exception being activities occurring in designated areas of Apra Harbor and at the bombing range on FDM as well as smaller areas described in detail in Chapter 2 (Description of Proposed Action and Alternatives). Most tourist activities engaged in by both visitors and residents take place within a few miles of land. No tourist activities occur on FDM, and the danger zones and restricted areas in Apra Harbor are open to the public except when training or testing activities are scheduled.

Snorkeling and diving take place primarily at known recreational sites, including shipwrecks and reefs. Temporary exclusion zones may be established for safety purposes, and would not adversely affect tourism activities because displacement is brief (hours) and the activity would typically not take place in areas where tourists are common. The military notifies the public of temporary limits on public access to certain areas when there is a risk of injury or property damage through the use of NOTMARs, HYDROPACs, and NOTAMs. Published notices allow recreational users to adjust their routes to avoid temporary exclusion zones. If civilian vessels transit into an exclusion zone at the time of a scheduled activity, military personnel may continue the activity if it is safe and possible to do so. If avoidance is not safe or possible, the activity may relocate or be delayed. In some instances where safety requires exclusive use of a specific area, non-participants in the area are asked to relocate to a safer area for the duration of the activity. Because military training and testing activities vary in location, are typically not coincident with popular tourist areas, and are primarily short-term in duration, impacts on tourism resulting from rerouting or delaying tourist activities would be negligible.

Other tourism activities such as whale watching, boating, or use of other watercraft may occur farther offshore and are conducted by boat, aircraft, or from land. These activities would be conducted with boats that are typically well marked and visible to military ships conducting training and testing activities. Individual boaters engaged in tourism activities, such as whale watching, plan and monitor navigational information to avoid military training and testing areas. Vessels are responsible for being aware of designated danger zones and restricted areas in surface waters and any NOTMARs that are in effect. Operators of recreational or commercial vessels have a duty to abide by maritime requirements as administered by the U.S. Coast Guard. At the same time, military vessels ensure that an area is clear of non-participants prior to testing and training exercises. As a result, conflicts between military training and testing activities in offshore areas and whale watching or other offshore recreational use are unlikely to occur. Changes to current offshore tourism activities in the MITT Study Area would not be expected from the proposed training and testing activities. Therefore, loss of revenue or employment associated with tourism would not occur.

The military would continue to recover many of the targets (e.g., mines and mine shapes) and target fragments used in training and testing activities so that they would not pose a collision risk to vessels. Unrecoverable items are typically small, constructed of soft materials (such as target cardboard boxes or tethered target balloons), or are intentionally designed to sink to the bottom after serving their purpose (such as expended 55-gallon steel drums), so that they would not represent a collision risk to vessels.

3.12.3.3.2 No Action Alternative

3.12.3.3.2.1 Training Activities

As described in Chapter 2 (Description of Proposed Action and Alternatives, Section 2.6), under the No Action Alternative, potential physical disturbance and strike stressors would be associated primarily with anti-air warfare, anti-surface warfare, anti-submarine warfare, mine warfare, and amphibious warfare. Training activities would continue at current levels and within established ranges and training locations.

There would be no anticipated impacts on commercial and recreational fishing, subsistence use, or tourism because of the large size of the MITT Study Area, the limited areas of operations, and implementation of the military's standard operating procedures, which includes ensuring that an area is clear of all non-participating vessels before training activities take place. In addition, the military provides advance notification of training activities to the public through NOTMARs and HYDROPACs. Damage to or loss of commercial fishing gear from interaction with military equipment or other expended materials is unlikely. The military recovers many practice munitions (e.g., mines and mine shapes) for reuse following the activity. The military also recovers larger floating objects or materials, such as targets or target fragments, to avoid having them become hazards to navigation. Smaller objects that remain in the water column would be unlikely to pose a risk to fishing gear. Considering the expansive size of the Navy's Operating Areas, the disbursement of Military Expended Materials over these large areas, and the effect of the military's standard operation procedures and mitigation measures (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring), impacts from physical disturbance and strike stressors on commercial and recreational fishing, subsistence use, or tourism would be negligible.

3.12.3.3.2.2 Testing Activities

Only one testing activity occurs under the No Action Alternative, the North Pacific Acoustic Lab Philippine Sea 2018–19 Experiment (Deep Water), as shown in Chapter 2 (Description of Proposed Action and Alternatives, Table 2.8-4). No impacts to commercial and recreational fishing, subsistence use, and tourism are anticipated from this testing activity because it takes place in deep, offshore waters.

3.12.3.3.3 Alternative 1

3.12.3.3.3.1 Training Activities

Under Alternative 1, potential physical disturbance and strike stressors would be the same as those associated with the No Action Alternative. Training activities and associated stressor components would increase, and there would be an associated increase in the quantity of Military Expended Materials released within the MITT Study Area. There would be no changes to the military's standard operating procedures for hazardous training activities performed in the MITT Study Area. The expansive size of the Navy's MITT Study Area, the disbursement of Military Expended Materials over this large area, and implementation of the military's standard operating procedures and mitigation measures (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) ensure that impacts from physical disturbance and strike stressors would be negligible. The advance public release of NOTMARs and HYDROPACs would inform the public of upcoming activities, and enable them to plan to avoid the area. Therefore, impacts from physical disturbance and strike stressors on commercial and recreational fishing, subsistence use, and tourism would be negligible.

3.12.3.3.3.2 Testing Activities

Under Alternative 1, testing activities and associated stressor components would increase over the No Action Alternative. The impact associated with physical disturbance and strike stressors would be negligible for the same reasons stated for training activities above. In addition, far fewer testing than training activities are proposed (see Chapter 2, Description of Proposed Action and Alternatives, Tables 2.8-2 to 2.8-4).

3.12.3.3.4 Alternative 2

3.12.3.3.4.1 Training Activities

Under Alternative 2, potential physical disturbance and strike stressors would be the same as those associated with the No Action Alternative. Training activities and associated stressor components would continue and would increase over the No Action Alternative and Alternative 1, and there would be an associated increase in the quantity of Military Expended Materials released within the MITT Study Area. There would be no changes to the military's standard operating procedures for hazardous training activities performed in the MITT Study Area. The expansive size of the Navy's Operating Areas, the disbursement of Military Expended Materials over these large areas, and implementation of the military's standard operating procedures and mitigation measures (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring) ensure that impacts from physical disturbance and strike stressors would be negligible. The advance public release of NOTMARs and HYDROPACs would inform the public of upcoming activities, and enable them to plan to avoid the area. Therefore, impacts from physical disturbance and strike stressors on commercial and recreational fishing, subsistence use, or tourism would be negligible.

3.12.3.3.4.2 Testing Activities

Under Alternative 2, testing activities and associated stressor components would increase over the No Action Alternative and Alternative 1. The impact associated with physical disturbance and strike stressors would be negligible for the same reasons stated for training activities above. In addition, far fewer testing than training activities are proposed (see Chapter 2, Description of Proposed Action and Alternatives, Tables 2.8-2 to 2.8-4).

3.12.3.4 Secondary Impacts from Availability of Resources

Socioeconomics could be impacted if the proposed activities led to changes to physical and biological resources to the extent that they would alter the way industries (e.g., fishing) can utilize those resources. The secondary stressor of resource availability pertains to the potential for loss of fisheries resources within the MITT Study Area.

Fishing, subsistence use, and tourism could be impacted if the proposed activities altered fish population levels to such an extent that these activities would no longer be able to find their target species. Similarly, disturbances to marine mammal populations could impact the whale watching industry. Analyses in Sections 3.4 (Marine Mammals), 3.8 (Marine Invertebrates), and 3.9 (Fish) determined, however, that no population level impacts on marine species are anticipated from the proposed training and testing activities. For these reasons, there would be no indirect impacts on commercial or recreational fishing, subsistence use, or tourism.

3.12.4 Summary of Potential Impacts (Combined Impacts of All Stressors) on Socioeconomics

Stressors described in this EIS/OEIS that have the potential to result in impacts on socioeconomic resources include, accessibility to areas within the MITT Study Area, airborne acoustics, physical disturbance and strike, and secondary stressors resulting from impacts on marine species populations. Under the No Action Alternative, Alternative 1, or Alternative 2, these activities would be widely dispersed throughout the MITT Study Area. Such activities also are dispersed temporally (i.e., few stressors would operate at the same time). Therefore, no greater impacts from the combined operation of more than one stressor are expected. The aggregate impact on socioeconomics would not observably differ from existing conditions.

This Page Intentionally Left Blank

REFERENCES

Aldan-Pierce, M. (2011). Mrs. Marian Aldan-Pierce, Chairperson of the Board of Directors MARIANAS VISITORS AUTHORITY Testimony on the implementation of PL 110-229, the Consolidated Natural Resources Act of 2008, July 14, 2011 (pp. 17). Commonwealth of the Northern Mariana Islands (CNMI).

Allen, S. & Bartram, P. (2008). Guam as a Fishing Community. Honolulu, Hawaii: Pacific Islands Fisheries Science Center. (p. 70).

Amesbury, J. R. & Hunter-Anderson, R. L. (1989). Native Fishing Rights and Limited Entry in Guam. Micronesian Archaeological Research Services. Retrieved from http://www.wpcouncil.org/indigenous/Limited%20Entry%20Guam.pdf, September 8.

Amesbury, J. R. & Hunter-Anderson, R. L. (2003). Review of archaeological and historical data concerning reef fishing in the U.S. flag islands of Micronesia: Guam and the Northern Mariana Islands. Final Report. [Report]. Prepared by N. Western Fishery Management Council.

Cohen, D. (2006). Statement of David B. Cohen Deputy Assistant Secretary of the Interior for Insular Affairs Before the Senate Committee on Energy and Natural Resources Regarding the State of the Economies and Fiscal Affairs of the Territories of American Samoa, the Commonwealth of the Northern Mariana Island, Guan and the United States Virgin Islands. United States Committee on Energy and Natural Resources. March 1, 2006. Retrieved from http://energy.senate.gov/public/index.cfm?FuseAction=Hearings.Testimony&Hearing_ID=0476d6b4-219c-400b-833e-7d7bd9890fee&Witness_ID=5fd3dbeb-d730-4f7e-bc13-ae4355e6de82 September 9.

Commonwealth of the Northern Mariana Islands. (1983). Lease Agreement Made Pursuant to the Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the United States of America. Commonwalth of the Northern Mariana Islands President of the Senate Governor and Speaker of the House, Chairman Board of Directors Mariana Public Land Corporation. DLR 13-1-119: 23.

Commonwealth Ports Authority. (2005). Commonwealth Ports Authority. Retrieved from http://www.cpa.gov.mp/default.asp, 18 January 2012.

Commonwealth Ports Authority. (2010). COMMONWEALTH PORTS AUTHORITY (A COMPONENT UNIT OF THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS) REPORT ON THE AUDIT OF FINANCIAL STATEMENTS IN ACCORDANCE WITH OMB CIRCULAR A-133 YEAR ENDED SEPTEMBER 30, 2009. Retrieved from http://www.cpa.gov.mp/financial/2009_audit_report.pdf, 03 February 2012.

Division of Fish and Wildlife and Western Pacific Fishery Information Network. (2007). COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS 2005 FISHERY STATISTICS. Retrieved from http://www.pifsc.noaa.gov/wpacfin/pdf_file/c_vol22.pdf

Division of Fish and Wildlife and Western Pacific Fishery Information Network. (2008). NORTHERN MARIANA ISLANDS 2006 FISHERY STATISTICS. Retrieved from http://www.pifsc.noaa.gov/wpacfin/pdf_file/c_vol23.pdf

Division of Fish and Wildlife and Western Pacific Fishery Information Network. (2009). NORTHERN MARIANA ISLANDS 2007 FISHERY STATISTICS. Retrieved from http://www.pifsc.noaa.gov/wpacfin/pdf_file/c_vol24.pdf

Division of Fish and Wildlife and Western Pacific Fishery Information Network. (2010). NORTHERN MARIANA ISLANDS 2008 FISHERY STATISTICS. Retrieved from http://www.pifsc.noaa.gov/wpacfin/pdf_file/c_vol25.pdf

Division of Fish and Wildlife and Western Pacific Fishery Information Network. (2011). COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS 2009 FISHERY STATISTICS. Retrieved from http://www.pifsc.noaa.gov/wpacfin/pdf_file/c_vol26.pdf

Eugenio, H. (2010). Obama delays CNMI wage hike for 2011. In *Saipan Tribune*. Retrieved from http://www.saipantribune.com/newsstory.aspx?newsID=103519&cat=1, September 9.

Federal Aviation Administration. (2009). APPENDIX A: NATIONAL AIRSPACE SYSTEM OVERVIEW FAA. Retrieved from http://www.faa.gov/air_traffic/nas_redesign/regional_guidance/eastern_reg/nynjphl_redesign/documentation/feis

First Hawaiian Bank. (2011). Uncertain Times for Guam's Tourism, Military Build-Up Economic Forecast, 2011-2012 Guam-CNMI Edition.

Guam Division of Aquatic and Wildlife Resources and the Western Pacific Fishery Information Network. (2007). GUAM 2005 FISHERY STATISTICS. Retrieved from http://www.pifsc.noaa.gov/wpacfin/pdf_file/g_vol22.pdf, 07 August.

Guam Division of Aquatic and Wildlife Resources and the Western Pacific Fishery Information Network. (2008). GUAM 2006 FISHERY STATISTICS. Retrieved from http://www.pifsc.noaa.gov/wpacfin/pdf_file/g_vol23.pdf, 07 August.

Guam Division of Aquatic and Wildlife Resources and the Western Pacific Fishery Information Network. (2009). GUAM 2007 FISHERY STATISTICS. Retrieved from http://www.pifsc.noaa.gov/wpacfin/pdf_file/g_vol24.pdf, 07 August.

Guam Division of Aquatic and Wildlife Resources and the Western Pacific Fishery Information Network. (2010). GUAM 2008 FISHERY STATISTICS. Retrieved from http://www.pifsc.noaa.gov/wpacfin/pdf_file/g_vol25.pdf, 07 August.

Guam Division of Aquatic and Wildlife Resources and the Western Pacific Fishery Information Network. (2011). GUAM 2009 FISHERY STATISTICS. Retrieved from http://www.pifsc.noaa.gov/wpacfin/pdf_file/g_vol26.pdf, 07 August.

Guam Economic Development Authority. (2008). Tourism. Retrieved from http://www.investguam.com/?pg=tourism, September 8.

Guam Legislature. (1997). An Act to Establish Rules and Regulations for the Control of Fisheries by the Department of Agriculture. Bill No. 49 (COR). Twenty-Fourth Guam Legislature. Guam. Public Law 24-21: 10.

Guam Visitors Bureau. (2006). Dive the exciting waters of Guam the Gateway to Micronesia. Retrieved from http://visitguam.org/dive/, September 8.

Guam Visitors Bureau. (2010). 2010 Annual Report & Membership Directory. Retrieved from http://www.visitguam.org/runtime/uploads/Files/Annual%20Report/2010/2011%20GVB%20Annual%20Report%20PART%201.pdf. September 8.

Hospital, J., and C. Beavers. (2012). Economic and social characteristics of Guam's small boat fisheries. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Pacific Islands

Fish. Sci. Cent. Admin. Rep. H-12-06, 60 p. + Appendices. Available from: http://www.pifsc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_12-06.pdf. February 20, 2013.

Kerr, A. (2011). Fishing Methods of the Mariana Islands, Micronesia. (Technical Report 132) University of Guam Marine Laboratory.

MacDuff, S. & Roberto, R. (2012). Chapter 3: Commonwealth of Northern Mariana Islands Fishery Ecosystem Report. In: M. Sabater (Ed.), *WPRFMC 2012. Archipelagic Fishery Ecosystem Annual Report.* Honolulu, Hawaii Western Pacific Regional Fishery Management Council.

Mintz, J. & Filadelfo, R. (2011). Exposure of Marine Mammals to Broadband Radiated Noise CNA Analysis & Solutions (Ed.), *Specific Authority N0001-4-05-D-0500*. (CRM D0024311.A2/Final, p. 42). Prepared for DoD Agencies.

Moffitt, R., Brodziak, J. & Flores, T. (2007). Status of the Bottomfish Resources of American Samoa, Guam, and Commonwealth of the Northern Mariana Islands, 2005 Pacific Islands Fisheries Science Center. Retrieved from http://www.pifsc.noaa.gov/adminrpts/2000-present/PIFSC_Admin_Rep_07-04.pdf on 07 <http://www.pifsc.noaa.gov/adminrpts/2000-present/PIFSC_Admin_Rep_07-04.pdf%20on%2007>, September 7.

Myers, R. (1993). Guam's Small-Boat-based Fisheries. *Marine Fisheries Review, 55*(2), 117-128. Retrieved from http://spo.nmfs.noaa.gov/mfr552/mfr55214.pdf Accessed online September 6, 2011.

National Oceanic and Atmospheric Administration. (1998). 1998 Year of the Ocean, Coastal Tourism and Recreation (Vol. 2011).

National Park Service. (2001). Special Study North Field Historic District. In *Tinian National Historical Park Study*. Retrieved from http://www.nps.gov/pwrh/Tinian/tiniandr.htm, Setember 9.

Naval Undersea Warfare Center. (2009). Southern California (SOCAL) Fisheries Study: Catch Statistics (2002-2007), Fishing Access, and Fishermen Perception Department of the Navy.

Office of Environmental Health Hazard Assessment. (1997). Consumption of Fish and Shellfish in California and the United States. In *Chemicals in Fish, Report No. 1, Final Draft Report*. Retrieved from http://oehha.ca.gov/fish/special_reports/fishy.html, September 8.

Orange Beach Fishing Charters. (2011). Orange Beach Fishing Definitions and Terms. Retrieved from http://www.fishingorangebeach.com/Alabama-Charter-Fishing-Definitions. Last updated September 6, 2011.

Pacific Business Center Program – University of Hawaii. (2008). Commonwealth of the Northern Marianas. Retrieved from http://pbcphawaii.com/commonwealth-of-the-northern-m.asp, September 8.

Pacific Islands Fisheries Science Center. (2006). Cruise Report *Oscar Elton Sette*, Cruise 05-12 *Cruite Period: 3-9 October 2005*. (p. 46). Available from: http://www.pifsc.noaa.gov/library/pubs/cruise/Sette/CR0512-1.RES.pdf. As Accessed on 20 February 2013.

Pacific Islands Fisheries Science Center. (2011). Bottom Fishery. Retrieved from http://www.pifsc.noaa.gov/wpacfin/cnmi/Pages/cnmi_fish_2.php, September 7.

Port Authority of Guam. (2011). Facts and Figures. In Facts and Figures | Facilities | Maritime Operations. Retrieved from http://www.portguam.com/maritime-operations/facilities/facts-and-figures, August 31.

Port Authority of Guam. (2012). Financial Statements and Other Financial Information. Ernst and Young. Retrieved from http://www.portguam.com/information/financial-information/annual-financial-audits.

Schultz, K. (2000). Ken Schultz's Fishing Encyclopedia: Worldwide Angling Guide John Wiley and Sons, Inc.

The Samoa News. (2013). Fishing Limits Proposed For Protected Pacific Sites U.S. Interior: 'customary exchanges' could complicate regulations. 15 April 2013.

Tenorio, P. (2011). CNMI July 2011 Visitor Arrivals Down 23% Primary Markets Fall, Secondary Markets Strong. In *News Release* Marianas Visitors Authority. Retrieved from http://d10280496.a135.angil.net/images/library/PR%20NMI%20July%202011%20Arrival%20Trends%208-26.pdf <http://d10280496.a135.angil.net/images/library/PR%20NMI%20July%202011%20Arrival%20Tre%09nds%208-26.pdf> September 9.

Tibbats, B. and Flores, T. (2012). Chapter 2: Guam Fishery Ecosystem Report. In: WPRFMC 2012. Archipelagic Fishery Ecosystem Annual Report. Sabater, M. (Ed.) Western Pacific Regional Fishery Management Council. Honolulu, Hawaii 96813 USA. Retrieved on 20 February 2013 from: http://www.wpcouncil.org/documents/Reports/annualreports/Annual%20Archipelagic%20Fishery%20Ecosystem%20Report%202012_FINAL.pdf

U.S. Environmental Protection Agency. (2002). Economic and Benefits Analysis for the Proposed Section 316(b) Phase II Existing Facilities Rule. 2011: EPA-821-R-802-001. Retrieved 25 February 2013 from: http://nepis.epa.gov/Exe/ZyNET.exe/20002R4F.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2000+Thru+2005&Docs=&Query=821R02001&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=pubnumber%5E%22821R02001%22&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=pubnumber&IntQFieldOp=1&ExtQFieldOp=1&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C00thru05%5CTxt%5C00000005%5C20002R4F.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=10&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL# <http://nepis.epa.gov/Exe/ZyNET.exe/20002R4F.TXT?ZyActionD=ZyDocument&Client=EPA&Inde%09x=2000+Thru+2005&Docs=&Query=821R02001&Time=&EndTime=&SearchMethod=1&TocRestr%09ict=n&Toc=&TocEntry=&QField=pubnumber%5E%22821R02001%22&QFieldYear=&QFieldMont%09h=&QFieldDay=&UseQField=pubnumber&IntQFieldOp=1&ExtQFieldOp=1&XmlQuery=&File=D%25%093A%5Czyfiles%5CIndex%20Data%5C00thru05%5CTxt%5C00000005%5C20002R4F.txt&User=AN%09ONYMOUS&Password=anonymous&SortMethod=h%7C-%09&MaximumDocuments=10&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Di%09splay=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20p%09age&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL>

U.S. Department of the Navy. (2007). Final Comprehensive Report for the Operation of the Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar Onboard the R/V Cory Chouset and USNS IMPECCABLE (T-AGOS 23) Under the National Marine Fisheries Service Regulations 50 C.F.R. 216 Subpart Q**:** 100.

U.S. Department of the Navy. (2009). ASSESSMENT OF NEAR SHORE MARINE RESOURCES AT FARALLON DE MEDINILLA: 2006, 2007 AND 2008 COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS.

U.S. Department of the Navy. (2010a). Final Environmental Impact Statement (FEIS) for the Guam and the Commonwealth of the Northern Mariana Islands (CNMI) Military Relocation. Volume 2, Chapter 14 Marine Transportation. Retrieved from http://www.guambuildupeis.us/, 03 February 2012.

U.S. Department of the Navy. (2010b). Final Environmental Impact Statement (FEIS) for the Guam and the Commonwealth of the Northern Mariana Islands (CNMI) Military Relocation. Volume 3, Chapter 16 Socioeconomics and General Services. Retrieved from http://www.guambuildupeis.us/, 03 February 2012.

U.S. Deparment of the Navy. (2013). Environmental Assessment/Overseas Environmental Assessment Mariana Islands Range Complex Airspace.

van Beukering, P., Wolfgang, H., Longland, M., Cesar, H., Sablan, J., Shjegstad, S., . . . Garces, G. (2007, Last updated March). The economic value of Guam's coral reefs. In *University of Guam Marine Laboratory Technical Report No. 116*. Retrieved from <http://www.guammarinelab.com/publications/uogmltechrep116.pdf>, September 8.

Western Pacific Fisheries Information Network. (2010). WPacFIN Central 1982-2009 Commercial Landings (Millions of Pounds) for CNMI, Guam, Samoa, and Hawaii. In *Chart and tabulated values of the WPacFIN Central 1982-2009 Commerical Landings*. Retrieved from http://www.pifsc.noaa.gov/wpacfin/central/Data/annual1.htm, September 7.

Western Pacific Fisheries Information Network. (2011a). WPacFIN Central 1982-2009 Commercial Landings (Millions of Dollars) for CNMI, Guam, Samoa, and Hawaii. In *Chart and tabulated values of the WPacFIN Central 1982-2009 Commerical Landings*. Retrieved from http://www.pifsc.noaa.gov/wpacfin/central/Data/annual1.htm, September 7.

Western Pacific Fisheries Information Network. (2011b). WPacFIN Central 1982-2009 Commercial Landings (Millions of Pounds) for CNMI, Guam, Samoa, and Hawaii. In *Chart and tabulated values of the WPacFIN Central 1982-2009 Commerical Landings*. Retrieved from http://www.pifsc.noaa.gov/wpacfin/central/Data/annual1.htm, September 7.

Western Pacific Regional Fishery Management Council. (No Date). Mariana Archipelago: Today’s Fisheries Retrieved from http://www.wpcouncil.org/MarianasFEP-fisheriestoday.html, 20 April 2012.

Western Pacific Regional Fishery Management Council. (2005). Fishery Ecosystem Plan for the Mariana Archipelago. Retrieved from http://www.wpcouncil.org/mariana/MarianasFEP/December12005MarianaFEP.pdf, 07 August.

Western Pacific Regional Fishery Management Council. (2009). *Fishery Ecosystem Plan for the Mariana Archipelago*. (p. 231). Honolulu, HI: Western Pacific Regional Fishery Management Council.

World Port Source. (2012a). Roto West Harbor Port of Call. Retrieved from http://www.worldportsource.com/ports/portCall/MNP_Rota_West_Harbor_1943.php, 03 February 2012

World Port Source. (2012b). Port of Tinian Port of Call. Retrieved from http://www.worldportsource.com/ports/portCall/MNP_Port_of_Tinian_1942.php, 03 February 2012.

World Port Source. (2012c). Port of Saipan Port of Call. Retrieved from http://www.worldportsource.com/ports/portCall/MNP_Port_of_Saipan_171.php, 03 February 2012.

This Page Intentionally Left Blank

3.13 Public Health and Safety

TABLE OF CONTENTS

LIST OF TABLES

There are no tables in this section.

LIST OF FIGURES

This Page Intentionally Left Blank

3.13 PUBLIC HEALTH AND SAFETY

PUBLIC HEALTH AND SAFETY SYNOPSIS

The United States Department of the Navy considered all potential stressors, and the following have been analyzed for public health and safety:

- Underwater energy
- In-air energy
- Physical interactions
- Secondary

Preferred Alternative (Alternative 1)

- Because of the Navy's standard operating procedures, impacts on public health and safety would be unlikely.

3.13.1 INTRODUCTION AND METHODS

3.13.1.1 Introduction

This section analyzes potential impacts on public health and safety within the Mariana Islands Training and Testing (MITT) Study Area (Study Area). Unlike military training and testing activities conducted within the boundaries of a fenced land installation, public access to ocean areas or to the overlying airspace cannot be physically controlled. The United States (U.S.) Department of the Navy (Navy) coordinates use of these areas through the scheduling of activities, and issues warnings and notices to the public prior to conducting potentially hazardous activities (Section 3.13.2.2, Safety and Inspection Procedures). Sensitivity to public health and safety concerns within the Study Area is heightened in areas where the public may be close to certain activities (e.g., pierside testing or littoral training).

Generally, the greatest potential for a proposed activity to affect the public is near the coast because that is where public activities are concentrated. These coastal areas could include dive sites or other recreational areas where the collective health and safety of groups of individuals that could be exposed to the hazards of training and testing would be of concern. Most commercial and recreational marine activities are close to the shore and are usually limited by the capabilities of the boat used. Commercial and recreational fishing may extend as far out as 100 nautical miles (nm) from shore but are concentrated near the coast.

3.13.1.2 Methods

Baseline public health and safety conditions were derived from the current training and testing activities. Existing procedures for ensuring public health and safety and other elements of the baseline (e.g., restricted areas) were derived from federal regulations, Department of Defense (DoD) directives, and Navy instructions for training and testing. The directives and instructions provide specifications for mission planning and execution that describe criteria for public health and safety considerations. These directives and instructions include criteria for public health and safety considerations for training and testing planning and execution.

The alternatives were evaluated based on two factors: the potential for a training or testing activity to impact public health and safety, and the degree to which those activities could have an impact. The likelihood that the public would be near a training or testing activity determines the potential for exposure to the activity. If the potential for exposure exists, the degree of the potential impacts on public health and safety, including increased risk of injury or loss of life, is determined. If the potential for exposure were zero, then public health and safety would not be affected. Isolated incidents and other conditions that affect single individuals, although important for safety awareness, may not rise to the level of a public health or safety issue and are not considered in this assessment (e.g., airborne noise effects are not addressed in this section).

3.13.2 AFFECTED ENVIRONMENT

3.13.2.1 Overview

The area of interest for assessing potential impacts on public health and safety is the U.S. Territorial Waters of the island of Guam and the islands of the Commonwealth of the Northern Mariana Islands (CNMI) (seaward of the mean high water line to 12 nm). Military, commercial, institutional, and recreational activities take place simultaneously in the Study Area (Figure 3.13-1) and have coexisted safely for decades. These activities coexist because established rules and practices lead to safe use of the waterway and airspace. The following paragraphs briefly discuss the rules and practices for recreational, commercial, and military use in sea surface areas and airspace.

Figure 3.13-1: Simultaneous Activities within the Mariana Islands Training and Testing Study Area

3.13.2.1.1 Sea Space

Most of the sea space in the Study Area is accessible to recreational and commercial activities. However, some activities are prohibited or restricted in certain areas (e.g., danger zones and restricted areas) in accordance with Title 33 Code of Federal Regulations (C.F.R.) Part 334 (Danger Zone and Restricted Area Regulations). These restrictions can be permanent or temporary. Nautical charts issued by the National Oceanic and Atmospheric Administration include these federally designated zones and areas. Operators of recreational and commercial vessels have a duty to abide by maritime regulations administered by the U.S. Coast Guard.

In accordance with Title 33 C.F.R. 72 (Aids to Navigation), the U.S. Coast Guard and the Department of Homeland Security inform private and commercial vessels about temporary closures via Notices to Mariners (NOTMARs). These notices provide information about durations and locations of closures because of activities that are hazardous to surface vessels. Broadcast notices on maritime frequency radio, weekly publications by the appropriate U.S. Coast Guard Navigation Center, and global positioning system navigation charts disseminate these navigational warnings.

3.13.2.1.2 Airspace

Most of the airspace in the Study Area is accessible to general aviation (recreational, private, corporate) and commercial aircraft. Like waterways, however, some areas are temporarily off limits to civilian and commercial use. The Federal Aviation Administration (FAA) has established Special Use Airspace—airspace of defined dimensions wherein activities must be confined because of their nature or wherein limitations may be imposed upon aircraft operations that are not part of those activities (U.S. Department of Transportation Federal Aviation Adminstration 2013). Additional discussion on airspace is provided in Section 3.12 (Socioeconomic Resources). Special Use Airspace in the Study Area includes:

- **Restricted Airspace:** Areas where aircraft are restricted because of unusual (often invisible) hazards to aircraft (e.g., release of ordnance). Some areas are under strict control of the DoD, and some are shared with nonmilitary agencies.
- **Warning Areas:** Areas of defined dimensions, beyond 3 nm from the coast of the United States, which warn nonparticipating aircraft of potential danger.
- **Air Traffic Controlled Assigned Airspace:** Airspace that is defined by the FAA and is not over an existing operating area. This airspace is used to contain specified activities, such as military flight training, that are segregated from other instrument flight rules air traffic. Air traffic controlled assigned airspace is not classified as special use airspace in accordance with FAA definition and airspace classification.

Notices to Airmen (NOTAMs) are created and transmitted by government agencies and airport operators to alert aircraft pilots of any hazards en route to or at a specific location. The FAA issues NOTAMs to disseminate information on upcoming or ongoing military exercises with airspace restrictions. Civilian aircraft are responsible for being aware of restricted airspace and any NOTAMs that are in effect. Pilots have a duty to abide by aviation rules as administered by the FAA.

Weather conditions dictate whether aircraft (general aviation, commercial, or military) can fly under visual flight rules or whether instrument flight rules are required. Under visual flight rules, the weather is favorable and the pilot is required to remain clear of clouds by specified distances to ensure separation from other aircraft under the concept of see and avoid. Pilots flying under visual flight rules must be able to see outside of the cockpit, control the aircraft’s altitude, navigate, and avoid obstacles and other aircraft based on visual cues. Pilots flying under visual flight rules assume responsibility for their separation from all other aircraft, and are generally not assigned routes or altitudes by air traffic control.

During unfavorable weather, pilots must follow instrument flight rules. Factors such as visibility, cloud distance, cloud ceilings, and weather phenomena cause visual conditions to drop below the minimums required to operate by visual flight referencing. Instrument flight rules are the regulations and restrictions a pilot must comply with when flying in weather conditions that restrict visibility. Pilots can fly under instrument flight rules in visual flight rules weather conditions; however, pilots cannot fly under visual flight rules in instrument flight rules weather conditions.

3.13.2.2 Safety and Inspection Procedures

During training and testing, the military services have policies in place to ensure the safety and health of personnel and the general public. The military services achieve these conditions by considering location when planning activities, scheduling and notifying potential users of an area, and ensuring that an area is clear of nonparticipants. The military services also have a proactive and comprehensive program of compliance with applicable standards and implementation of safety management systems.

As previously stated, the greatest potential for a training or testing activity to affect the public is in coastal areas because of the concentration of public activities. When planning a training or testing activity, the military services consider proximity of the activity to public areas in choosing a location. Important factors considered include the ability to control access to an area; schedule (time of day, day of week); frequency, duration, and intensity of activities; range safety procedures; operational control of activities or events; and safety history.

The Navy's Fleet Area Control and Surveillance Facilities actively manage assigned airspace, operating areas, ranges, and training and testing resources to enhance combat readiness of U.S. Pacific Fleet units. The Navy schedules activities through the Fleet Area Control and Surveillance Facilities, which coordinate air and surface use of the training areas with the FAA and the U.S. Coast Guard, which issue NOTAMs and NOTMARs, respectively.

During training and testing activities in the Study Area, the military services ensure that the appropriate safety zone is clear of nonparticipants before engaging in certain activities, such as firing weapons. Inability to obtain a "clear range" could cause an event to be delayed, cancelled, or relocated. Military procedures ensure public safety during military activities that otherwise could harm nonparticipants. Military practices employ the use of sensors and other devices (e.g., radar) to ensure public health and safety while conducting training and testing activities. The following subsections outline the current requirements and practices for human safety as they pertain to range safety procedures, range inspection procedures, exercise planning, and scheduling and coordinating procedures for the military services.

Active management of assigned airspace, operating areas, ranges, and training and testing resources to enhance combat readiness of U.S. military service units in all warfare areas in the Study Area are provided by the Mariana Islands Range Complex (MIRC) Operations, in coordination with the FAA, Naval Base Guam Security or 36th Wing Operations Group (Andersen Air Force Base). Training participants comply with published safety procedures in the Joint Region Marianas Instruction 3500.4A (Marianas Training Manual) (U.S. Department of the Navy 2011a) for training and testing activities in the Study Area. These guidelines apply to range users as follows:

- Military personnel are responsible for ensuring that impact areas and targets are clear before commencing hazardous activities.
- The use of underwater ordnance must be coordinated with submarine operational authorities. The coordination also applies to towed sound navigation and ranging (sonar) arrays and torpedo decoys.
- Aircraft or vessels expending ordnance shall not commence firing without permission of the Range Safety Officer for their specific range area.

- Firing units and targets must remain in their assigned areas, and units must fire in accordance with current safety instructions.
- Aircraft carrying ordnance to or from ranges shall avoid populated areas to the maximum extent possible.
- Strict on-scene procedures include the use of ship sensors, visual surveillance of the range from aircraft and range safety boats, and radar and acoustic data to confirm the firing range and target area are clear of civilian vessels, aircraft, or other nonparticipants.

Testing activities have their own comprehensive safety planning instructions (U.S. Department of the Navy 2011a). These instructions provide guidance on how to identify the hazards, assess the potential risk, analyze risk control measures, and review safety procedures. They apply to all testing activities, including ground, waterborne, and airborne testing activities involving personnel, aircraft, inert minefields, equipment, and airspace. The guidance applies to system program managers, program engineers, test engineers, test directors, and aircrews that are responsible for incorporating safety planning and review when conducting test programs.

The following safety and inspection procedures are implemented for training activities. Each commanding officer is responsible for implementing safety and inspection procedures for activities inside and outside established ranges. In the absence of specific guidance on matters of safety, the military follows the most prudent course of action. The following contains information on the military's program of compliance with applicable standards and implementation of safety management systems.

3.13.2.2.1 Aviation Safety

Navy procedures on planning and managing Special Use Airspace are provided in the Chief of Naval Operations Instruction 3770.2K, *Airspace Procedures and Planning Manual* (U.S. Department of the Navy 2007). Navy and Air Force aircraft operating over the high seas comply with DoD Directive 4540.1, *Use of Airspace by U.S. Military Aircraft and Firings Over the High Seas*, and Chief of Naval Operations Instruction 3770.4A, *Use of Airspace by U.S. Military Aircraft and Firing Over the High Seas*, which specify procedures for conducting aircraft maneuvers and for firing missiles and projectiles. The missile and projectile firing areas are to be selected "so that trajectories are clear of established oceanic air routes or areas of known surface or air activity" (U.S. Department of Defense 1981).

Aircrews involved in a training or testing exercise must be aware that nonparticipating aircraft and ships are not precluded from entering the area and may not comply with NOTAMs or NOTMARs. Aircrews are required to maintain a continuous lookout for nonparticipating aircraft while operating in warning areas under visual flight rules. In general, aircraft carrying ordnance are not allowed to fly over surface vessels.

Part of aviation safety during training and testing activities is the implementation of the Bird/Animal Aircraft Strike Hazard program. The Bird Aircraft Strike Hazard program manages risk by addressing specific aviation safety hazards associated with wildlife near airfields through coordination among all the entities supporting the aviation mission (U.S. Department of Defense 2012). The Bird Aircraft Strike Hazard program strives to effectively minimize secondary consequences of strikes, such as damage to aircraft, environmental cleanup due to aircraft crashes, and impairment of training (U.S. Department of Defense 2012), at the same time precluding potential impacts to public health and safety. The Bird Aircraft Strike Hazard program is defined in the Navy Bird/Animal Aircraft Strike Hazard Program Implementing Guidance (Commander, Navy Installations Command Instruction 3700) (U.S. Department of Defense 2012) and the Bird/Animal Aircraft Strike Hazard Manual (U.S. Department of the Navy 2010).

The Bird Aircraft Strike Hazard program consists of, among other things, identifying the bird/animal species involved and the location of the strikes to understand why the species is attracted to a particular area of the airfield or training route. By knowing the species involved, managers can understand the habitat and food habits of the species. A Wildlife Hazard Assessment identifies the areas of the airfield that are attractive to the wildlife and provides recommendations to remove or modify the attractive feature. Recommendations may include the removal of unused airfield equipment to eliminate perch sites, placement of anti-perching devices, wiring of streams and ponds, removal of brush/trees, use of pyrotechnics, and modification of the grass mowing program (U.S. Department of Defense 2012).

3.13.2.2.2 Submarine Navigation Safety

Submarine crews use various methods to avoid collisions while they are surfaced, including visual and radar scanning, acoustic depth finders, and state-of-the-art satellite navigational systems. When transiting submerged, submarines use all available ocean navigation tools, including inertial navigational charts that calculate position based on the submerged movements of the submarine. Areas with surface vessels can then be avoided to protect both the submarines and surface vessels.

3.13.2.2.3 Surface Vessel Navigational Safety

The Navy practices the fundamentals of safe navigation. While in transit, Navy surface vessel operators are alert at all times, use extreme caution, use state-of-the-art satellite navigational systems, and are trained to take proper action if there is risk. Surface vessels are also equipped with trained and qualified Navy lookouts. Individuals trained as lookouts have the necessary skills to detect objects or activity in the water that could potentially be a risk for the vessel.

For specific testing activities, like unmanned surface vehicle testing, a support boat would be used near the testing to ensure safe navigation. Before firing or launching a weapon or radiating a non-eyesafe laser, Navy surface vessels are required to determine that all safety criteria have been satisfied. When applicable, the surface vessel would use aircraft and other boats to aid in navigation. In accordance with Navy instructions presented in this chapter, safety and inspection procedures ensure public health and safety.

3.13.2.2.4 Sound Navigation and Sounding (Sonar) Safety

Surface vessels and submarines may use active sonar in the pierside locations listed in Chapter 2 (Description of Proposed Action and Alternatives) and during transit to the training or testing exercise location. To ensure safe and effective sonar use, the Navy applies the same safety procedures for pierside sonar use as described in Section 3.13.2.2 (Safety and Inspection Procedures).

Naval Sea Systems Command Instruction 3150.2, Appendix 1A, *Safe Diving Distances from Transmitting Sonar*, is the Navy's governing document for protecting divers during active sonar use (U.S. Department of the Navy 2011b). This instruction provides procedures for calculating safe distances from active sonar. These procedures are derived from experimental and theoretical research conducted at the Naval Submarine Medical Research Laboratory and the Navy Experimental Diving Unit. Safety distances vary based on conditions that include diver attire, type of sonar, and duration of time in the water. Some safety procedures include onsite measurements during testing activities to identify an exclusion area for nonparticipating swimmers and divers.

3.13.2.2.5 Electromagnetic Energy Safety

All frequencies (or wavelengths) of electromagnetic energy are referred to as the electromagnetic spectrum, and they include electromagnetic radiation and radio frequency radiation. Communications and electronic devices such as radar, electronic warfare devices, navigational aids, two-way radios, cell phones, and other radio transmitters produce electromagnetic radiation. While such equipment emits electromagnetic energy, some of these systems are the same as, or similar to, civilian navigational aids and radars at local airports and television weather stations. Radio waves and microwaves emitted by transmitting antennas are a form of electromagnetic energy, collectively referred to as radio frequency radiation. Radio frequency energy includes frequencies ranging from 0 to 3,000 gigahertz. Exposure to radio frequency energy of sufficient intensity at frequencies between 3 kilohertz and 300 gigahertz can adversely affect people, ordnance, and fuel.

To avoid excessive exposures from electromagnetic energy, military aircraft are operated in accordance with standard operating procedures that establish minimum separation distances between electromagnetic energy emitters and people, ordnance, and fuels (U.S. Department of Defense 2009a). Thresholds for determining hazardous levels of electromagnetic energy to humans, ordnance, and fuel have been determined for electromagnetic energy sources based on frequency and power output, and current practices are in place to protect the public from electromagnetic radiation hazards (U.S. Department of Defense 2002, 2009a). These procedures include setting the heights and angles of electromagnetic energy transmissions to avoid direct exposure, posting warning signs, establishing safe operating levels, activating warning lights when radar systems are operational, and not operating some platforms that emit electromagnetic energy within 15 nm of shore. Safety planning instructions provide clearance procedures for nonparticipants in operational areas prior to conducting training and testing (U.S. Department of the Navy 2011a) activities that involve underwater electromagnetic energy (e.g., mine warfare).

Mine warfare devices are analyzed under other resources in this Environmental Impact Statement (EIS)/Overseas EIS (OEIS) because they emit electromagnetic energy. The electromagnetic impacts from mine warfare devices are very local, unlike radars and radios. Measures to avoid public interaction with mine warfare devices are effective in protecting the public from these impacts. As discussed in Section 3.0.5.3.3.2 (Kinetic Energy Weapon), electromagnetic fields generated by kinetic energy weapon testing would likely be shielded and contained on the vessel as to not affect other shipboard systems. Therefore, there will be no impacts to the public from testing of the kinetic energy weapon.

3.13.2.2.6 Laser Safety

Lasers produce light energy. The military uses tactical lasers for precision range finding, as target designation and illumination devices for engagement with laser-guided weapons, and for mine detection and mine countermeasures. Laser safety procedures for aircraft require an initial pass over the target prior to laser activation to ensure that target areas are clear. The military observes strict precautions, and has written instructions in place for laser users to ensure that nonparticipants are not exposed to intense light energy. During actual laser use, aircraft run-in headings are restricted to avoid unintentional contact with personnel or nonparticipants. Personnel participating in laser training activities are required to complete a laser safety course (U.S. Department of the Navy 2008).

3.13.2.2.7 High-Explosive Ordnance Detonation Safety

Pressure waves from underwater detonations can pose a physical hazard in surrounding waters. Before conducting an underwater training or testing activity, Navy personnel establish an appropriately sized exclusion zone to avoid exposure of nonparticipants to the harmful intensities of pressure. Naval Sea Systems Command Instruction 3150.2, Chapter 2, *Safe Diving Distances from Transmitting Sonar*, provides procedures for determining safe distances from underwater explosions (U.S. Department of the Navy 2011b). In accordance with training and testing procedures for safety planning related to detonations (Section 3.13.2.2.8, Weapons Firing and Ordnance Expenditure Safety), the Navy uses the following general and underwater detonation procedures:

- Navy personnel are responsible for ensuring that impact areas and targets are clear before commencing hazardous activities.
- The use of underwater ordnance must be coordinated with submarine operational authorities.
- Aircraft or vessels expending ordnance shall not commence firing without permission of the Range Safety Officer or Test Safety Officer for their specific range area.
- Firing units and targets must remain in their assigned areas, and units must fire in accordance with current safety instructions.
- Detonation activities will be conducted during daylight hours.

3.13.2.2.8 Weapons Firing and Ordnance Expenditure Safety

In accordance with safety and inspection procedures (U.S. Department of the Navy 2011a), any unit firing or expending ordnance shall ensure that all possible safety precautions are taken to prevent accidental injury or property damage. The officer conducting the exercise shall permit firing or jettisoning of aerial targets only when the area is confirmed to be clear of nonparticipating units, both civilian and military.

Safety is a primary consideration for all training and testing activities. The range must be able to safely contain the hazard area of the weapons and equipment employed. The hazard area is based on the size and net explosive weight of the weapon. The type of activity determines the size of the buffer zone. For activities with a large hazard area, special sea and air surveillance measures are implemented to make sure that the area is clear before activities commence. Before aircraft can drop ordnance, they are required to make a preliminary pass over the intended target area to ensure that it is clear of boats, divers, or other nonparticipants. Aircraft carrying ordnance are not allowed to fly over surface vessels.

Training and testing activities are delayed, moved, or cancelled if there is any question about the safety of the public. Target areas must be clear of nonparticipants before conducting training and testing. When using ordnance with flight termination systems (which terminate the flight of airborne missiles or launch vehicles when they veer from their targeted path), the military is required to follow standard operating procedures to ensure public health and safety. In those cases where a weapons system does not have a flight termination system, the size of the target area that needs to be clear of nonparticipants is based on the flight distance of the weapon plus an additional distance beyond the system's performance capability.

3.13.3 Environmental Consequences

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) could impact public health and safety. In this section, each public health and safety stressor is introduced, analyzed by alternative, and analyzed for training activities and testing activities. Tables 2.8-1 through 2.8-4 present the baseline and proposed training and testing activity locations for each alternative (including the number of events and ordnance expended). The stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to public health and safety and analyzed below include the following:

- Underwater energy
- In-air energy
- Physical interactions
- Secondary

Alternatives 1 and 2 include the expansion of the Study Area boundary to the west and north of the existing MIRC to encompass the Marianas Trench Marine National Monument (to include both the Islands and Trench Units) and the Transit Corridor from the MIRC to Hawaii. While Alternatives 1 and 2 would adjust locations and tempo of training and testing activities, including the establishment of danger zones around existing training areas, existing safety procedures and standard operating procedures would be employed such that no new or additional impacts to public health and safety would occur. In addition, the establishment of danger zones that would result in the exclusion of the public from these training areas on a full-time or intermittent basis would be a beneficial impact in terms of public health and safety. Therefore, expansion of the Study Area boundary and establishment of danger zones will not be addressed further in the analysis below.

Potential public health and safety impacts were evaluated assuming continued implementation of the military's current safety procedures for each training and testing activity or group of similar activities. Generally, the greatest potential for the proposed activities to be co-located with public activities would be in coastal areas because most commercial and recreational activities occur close to the shore.

Training and testing activities in the Study Area are conducted in accordance with the Marianas Training Manual (U.S. Department of the Navy 2011a). The Marianas Training Manual provides operational and safety procedures for all normal range activities. The Manual also provides information to range users that is necessary to operate safely and avoid affecting non-military activities, such as shipping, recreational boating, diving, and commercial or recreational fishing. Ranges are managed in accordance with standard operating procedures that ensure public health and safety. Current requirements and practices (e.g., standard operating procedures) designed to prevent public health and safety impacts are identified in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring).

As part of its continuing improvement of training, the U.S. military services generate an After Action Report (as required in the Marianas Training Manual) at the end of a training or testing activity primarily to track ordnance and training area usage, and at the same time identify problems encountered, provide solutions to the problem, and solicit suggestions for improvement.

3.13.3.1 Underwater Energy

Underwater energy can come from acoustic sources or electromagnetic devices. Active sonar, underwater explosions, airguns, and vessel movements all produce underwater acoustic energy. Sound will travel from air to water during aircraft overflights. Electromagnetic energy can enter the water from mine warfare training devices and unmanned underwater systems. The potential for the public to be exposed to these stressors would be limited to individuals, such as recreational swimmers or self-contained underwater breathing apparatus (SCUBA) divers, who are underwater and within unsafe proximity of a training or testing activity.

Many of the proposed activities generate underwater acoustic energy; however, not all sources rise to the level of consideration in this EIS/OEIS. Swimmers or divers might intermittently hear ship noise or underwater acoustic energy from aircraft overflights if they are near a training or testing event, but public health and safety would not be affected because these events would be infrequent and short in duration. Pierside integrated swimmer defenses are tested with underwater airguns during swimmer defense and diver deterrent training and testing activities; public health and safety would be ensured for these localized activities because access to pierside locations by nonparticipants is controlled for safety and security reasons. Because of the infrequency and short duration of the events, underwater acoustic energy from vessel movements, aircraft overflights, and airguns is not analyzed in further detail. Active sonar and underwater explosions are the only sources of underwater acoustic energy evaluated for potential impacts on public health and safety.

The proposed activities that would result in underwater acoustic energy include activities such as amphibious warfare, anti-surface warfare, anti-submarine warfare, mine warfare, surface warfare testing, and sonar maintenance. A limited amount of active sonar would be used during transit between range complexes and training and testing locations.

The effect of active sonar on humans varies with the sonar frequency. Of the four types of sonar (very high-, high-, mid-, and low-frequency), mid-frequency and low-frequency sonar have the greatest potential to impact humans due to the range of human hearing. Underwater explosives cause a physical shock front that compresses the explosive material, and the pressure wave then passes into the surrounding water. Generally, the pressure wave would be the primary cause of injury. The effects of an underwater explosion depend on several factors, including the size, type, and depth of the explosive charge and where it is in the water column.

Systems like the Organic Airborne and Surface Influence Sweep emit an electromagnetic field and sound to simulate the presence of a ship. Unmanned underwater vehicles, some unmanned surface vehicles, and towed devices use electromagnetic energy. Electronic warfare activities involve aircraft, surface ship, and submarine crews attempting to control portions of the electromagnetic spectrum to degrade or deny the enemy’s ability to take defensive actions. An electromagnetic signal dissipates quickly with increasing distance from its source. The literature lacks evidence to conclude that any adverse health effects result from exposure to electromagnetic energy, which is why no federal standards have been set for occupational exposures to this type of energy. Because standard operating procedures require an exercise area to be clear of participants, the public would not be exposed to electromagnetic energy the way a worker could experience long-term, occupational exposures. In the unlikely event that the public was exposed, the level of electromagnetic energy associated with the Proposed Action would not be enough to pose a health or safety risk.

As previously stated, the potential for the public to be exposed to these stressors would be limited to divers within unsafe proximity of an event. SCUBA diving is a popular recreational activity that is typically concentrated around known dive attractions such as reefs and shipwrecks. In general, recreational divers should not exceed 130 feet (40 meters) (Professional Association of Diving Instructors 2011). This depth limit typically limits this activity’s distance from shore. Therefore, training and testing activities closest to shore have the greatest potential to co-occur with the public.

Swimmers and recreational SCUBA divers are not expected to be near Navy pierside locations because access to these areas is controlled for safety and security reasons. Locations of popular offshore diving spots are well documented, and dive boats (typically well marked) and diver-down flags would be visible from the ships conducting the training and testing. Therefore, co-occurrence of recreational divers and Navy activities is unlikely. Swimmers and recreational divers are not expected to be near training and testing locations where active sonar, underwater explosions, and electromagnetic activities would occur because of the strict procedures for clearance of nonparticipants before conducting activities.

The U.S. Navy Dive Manual (U.S. Department of the Navy 2011b) prescribes safe distances from active sonar sources and underwater explosions. Safety precautions for use of electromagnetic energy are specified in DoD Instruction 6055.11, *Protecting Personnel from Electromagnetic Fields* (U.S. Department of Defense 2002, 2009b) and Military Standard 464A, *Electromagnetic Environmental Effects: Requirements for Systems* (U.S. Department of Defense 2002). These distances would be used as the standard safety buffers for underwater energy to protect public health and safety. If unauthorized personnel are detected within the exercise area, the activity would be temporarily halted until the area was again cleared and secured. Therefore, the public is unlikely to be exposed to underwater energy at Navy pierside locations, in training or testing areas, or in ports.

3.13.3.1.1 No Action Alternative

3.13.3.1.1.1 Training Activities

Under the No Action Alternative, active sonar training activities such as anti-submarine warfare, mine warfare, and sonar maintenance would continue at current levels and at current locations. Navy training exercises would be confined within the Study Area in offshore areas and within Naval Base Guam Apra Harbor. See Figure 2.1-5 for locations of training areas and facilities associated with Naval Base Guam Apra Harbor. Most Navy training activities involving active sonar under the No Action Alternative would be conducted well out to sea, however, while most civilian activities are conducted within a few miles of the coast of Guam, the islands of the CNMI, and other island nations close to the Study Area.

Activities involving underwater explosions, such as anti-surface warfare and mine warfare, would also continue at current levels and at current locations. Target areas would be cleared of nonparticipants prior to conducting training, so the only public health and safety concern would be on the rare occasion when an activity exceeds the safety area boundaries. Safety hazard areas would be determined prior to conducting training, and the public would not be allowed into the safety training areas. Standard operating procedures would be followed at all times. This separation decreases the potential for conflicts of military and civilian activities, and reduces the potential for incidents from underwater energy that could threaten the safety of civilians.

The Navy would continue to temporarily limit public access to areas where training activities involving underwater explosions would occur and would issue NOTMARs. Public safety would continue to be enhanced by providing the public with information that would let them take an active role in avoiding interactions with Navy training involving sonar and underwater explosives and ensuring their own safety.

The analysis indicates that no impact on public health and safety would result from training activities using underwater energy, based on the Navy's implementation of strict operating procedures that protect public health and safety. These operating procedures include ensuring clearance of the area before commencing training activities involving underwater energy. Because of the Navy's safety procedures, the potential for training activities using underwater energy to impact public health and safety under the No Action Alternative would be unlikely.

3.13.3.1.1.2 Testing Activities

Under the No Action Alternative, the Navy would continue conducting deep water sound propagation and temperature-sound velocity profiles of the water column in the Study Area (refer to Table 2.4-4 for a complete description). Research vessels, acoustic test sources, side scan sonars, ocean gliders, existing moored acoustic topographic array and distributed vertical line array, and other oceanographic data collection equipment are used to collect information. Under the No Action Alternative, this activity would continue within the Study Area. Because of the Navy's safety procedures, the potential for this testing activity using underwater energy to impact public health and safety would be unlikely.

3.13.3.1.2 Alternative 1

3.13.3.1.2.1 Training Activities

Active sonar training activities would continue to occur at current locations under Alternative 1; however, the potential areas for these activities are expanded under Alternative 1. While Alternative 1 would adjust the locations and tempo of active sonar training activities, the Navy would continue to implement standard operating and safety procedures; therefore, an increased potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely.

Activities involving underwater explosions, such as anti-surface warfare and mine warfare, would also continue within established ranges and training locations, as described under the No Action Alternative. While Alternative 1 would adjust locations and tempos of underwater explosives training activities to include the expanded area of the Study Area and the designation of danger zones around underwater detonation sites, the Navy would continue to implement standard operating and safety procedures; therefore, an increased potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely. Public health and safety would be enhanced by the designation of danger zones around underwater detonation zones and associated restrictions on public access.

Mine warfare activities using electromagnetic energy include airborne mine countermeasures (e.g., Mine Countermeasure Exercise—Towed Sonar). While Alternative 1 would adjust locations and tempos of training activities with electromagnetic energy, the Navy would continue to implement standard operating and safety procedures; therefore, an increased potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely.

The Navy's safety procedures would ensure that the potential for training activities to impact public health and safety under Alternative 1 would be unlikely.

3.13.3.1.2.2 Testing Activities

Under Alternative 1, the Navy would continue conducting deep water sound propagation and temperature-sound velocity profiles of the water column in the Study Area and include other testing activities. The proposed testing activities include testing of anti-surface warfare and anti-submarine warfare systems. They would also include swimmer defense testing and testing of mission packages (anti-surface warfare, anti-submarine warfare, and mine countermeasure) associated with new ship construction (Tables 2.8-2 and 2.8-3). These proposed testing activities would occur within Navy-controlled and established ranges and locations. The Navy would implement standard operating and safety procedures similar to those used during training activities; therefore, an increased potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely. Public health and safety would be enhanced by the designation of danger zones around underwater detonation zones and associated restrictions on public access.

Because of the Navy's safety procedures, the potential for testing activities to impact public health and safety under Alternative 1 would be unlikely.

3.13.3.1.3 Alternative 2

3.13.3.1.3.1 Training Activities

Alternative 2 is similar to Alternative 1 in the increase in active sonar, underwater explosions, and electromagnetic activities over the No Action Alternative. Alternative 2 is identical to Alternative 1 in the proposed locations for these activities. As concluded under Alternative 1, because of the Navy's safety procedures, an increased potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely.

3.13.3.1.3.2 Testing Activities

Under Alternative 2, the same testing activities identified in Alternative 1 would be conducted. The Navy would continue conducting deep water sound propagation and temperature-sound velocity profiles of the water column in the Study Area. The proposed testing activities identified under Alternative 1 would increase slightly under Alternative 2 (Tables 2.8-2 and 2.8-3). These testing activities would occur within Navy-controlled and established ranges and locations and would not impact public health and safety. The Navy would implement the standard operating and safety procedures similar to those used during training activities; therefore, an increased potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely. Public health and safety would be enhanced by the designation of danger zones around underwater detonation zones and associated restrictions on public access. Because of the Navy's safety procedures, the potential for underwater testing activities to impact public health and safety under Alternative 2 would be negligible.

3.13.3.2 In-Air Energy

In-air energy stressors include sources of electromagnetic energy and lasers. The sources of electromagnetic energy include radar, navigational aids, and electronic warfare systems. These systems operate similarly to other navigational aids and radars at local airports and television weather stations throughout the U.S. Electronic warfare systems emit electromagnetic energy similar to that from cell phones, hand-held radios, commercial radio stations, and television stations. Current practices are in place to protect military personnel and the public from electromagnetic energy hazards. These procedures include setting the heights and angles of electromagnetic energy transmissions to avoid direct human exposure, posting warning signs, establishing safe operating levels, and activating warning lights when radar systems are operational. Procedures also are in place to limit public and participant exposure from electromagnetic energy emitted by military aircraft. As stated in Section 3.13.3.1 (Underwater Energy), the level of electromagnetic energy associated with the Proposed Action would not be enough to pose a health or safety risk to the public.

A comprehensive safety program exists for the use of lasers. Current DoD and Navy practices protect individuals from the hazard of severe eye injury caused by laser energy. Laser safety requires pilots to verify that target areas are clear before commencing an exercise. In addition, during actual laser use, the aircraft run-in headings are restricted to preclude inadvertent lasing of areas where the public may be present.

Training and testing activities involving electromagnetic energy include electronic warfare activities that use airborne and surface electronic jamming devices to defeat tracking and communications systems. Training activities involving low-energy lasers include anti-surface warfare, mine warfare, and Homeland

Security/Anti-Terrorism Force Protection with Unmanned Aerial Vehicles. Proposed testing activities that involve low-energy lasers include mine countermeasure mission package testing.

3.13.3.2.1 No Action Alternative

3.13.3.2.1.1 Training Activities

Under the No Action Alternative, electronic warfare training activities involving electromagnetic energy sources would continue at current levels and current locations within the MIRC. Laser targeting activities and mine detection activities using lasers also would continue at current levels and within established ranges and training locations within the MIRC.

The public would not likely be exposed to electromagnetic energy sources or lasers under the No Action Alternative. Based on the military's strict safety procedures for use of lasers and electronic warfare, these activities would not likely be conducted close enough to the public to pose an increased risk. Because of the military's safety procedures, the potential for these training activities to impact public health and safety under the No Action Alternative would be negligible.

3.13.3.2.1.2 Testing Activities

Under the No Action Alternative, the Navy would continue conducting the North Pacific Acoustic Lab Philippine Sea Experiment in deep water in the Study Area (refer to Table 2.4-4 for a complete description). This testing activity does not involve any in-air energy source; therefore, there would be no impact on public health and safety from in-air energy sources.

3.13.3.2.2 Alternative 1

3.13.3.2.2.1 Training Activities

Under Alternative 1, the number of training activities that use electromagnetic energy would increase (Table 2.8-1) and would continue to occur within established ranges and training locations, as described under the No Action Alternative. Laser targeting activities and mine detection activities using lasers would increase but would also occur within established ranges and training locations.

While Alternative 1 would increase locations and tempo of training activities involving electromagnetic energy and lasers, the military would continue to implement standard operating and safety procedures. Therefore, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely to increase.

3.13.3.2.2.2 Testing Activities

Under Alternative 1, proposed testing activities that use electromagnetic energy and lasers would occur within established ranges and testing locations. Locations proposed under this alternative include ocean areas of the MIRC and to the west and north of the MIRC.

The Navy would implement standard operating and safety procedures similar to those used during training activities; therefore, the potential for impacts on public health and safety from testing activities under Alternative 1 would be unlikely.

3.13.3.2.3 Alternative 2

3.13.3.2.3.1 Training Activities

Alternative 2 is similar to Alternative 1 in the increase in electromagnetic energy and laser training activities over the No Action Alternative. Alternative 2 is identical to Alternative 1 in the proposed locations for these activities. As concluded under Alternative 1, impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely.

While Alternative 2 would adjust locations and tempo of training activities involving electromagnetic energy and lasers, the military would continue implementation of standard operating and safety procedures; therefore, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be unlikely to increase.

3.13.3.2.3.2 Testing Activities

Similar to the analysis under Alternative 1, Alternative 2 would involve an increase in testing activities that use electromagnetic energy and lasers. Electromagnetic energy would occur in established location and ranges in the Study Area. Changes in the locations and tempo of testing activities that use electromagnetic energy and lasers would not impact public health and safety because safety procedures would be in place.

While Alternative 2 would adjust locations and tempo of testing activities involving electromagnetic energy and lasers, the military would implement standard operating and safety procedures similar to those used during training activities; therefore, the potential for impacts on public health and safety from testing activities under Alternative 2 would be unlikely to increase.

3.13.3.3 Physical Interactions

Public health and safety could be impacted by direct physical interactions with military training and testing activities. Military aircraft, vessels, targets, munitions, towed devices, seafloor devices, and other training and testing expended materials could have a direct physical encounter with recreational, commercial, institutional, and governmental aircraft, vessels, and users such as swimmers, divers, and anglers, as well as wildlife.

Both military and public aircraft operate under visual flight rules requiring them to observe and avoid other aircraft. In addition, NOTAMs advise pilots about when and where Navy and Air Force training and testing activities are scheduled. Finally, Navy and Air Force personnel are required to verify that the range is clear of nonparticipants before initiating any potentially hazardous activity. Together, these procedures would minimize the potential for adverse interactions between Navy, Air Force, and nonparticipant aircraft. Standard operating procedures of the Navy and the Air Force ensure that private and commercial aircraft traversing the Study Area during training or testing activities do not interact with Navy and Air Force aircraft, ordnance, and aerial targets.

Wildlife in the area is also subject to interactions with Navy and Air Force aircraft during training and testing activities. The military installations in the Study Area have an ongoing comprehensive Bird Aircraft Strike Hazard program to discourage wildlife from occupying areas of the airfield and adjacent areas. The program would minimize the occurrence of adverse interactions between military aircraft and wildlife, particularly bird/animal aircraft strikes.

Both Navy and public vessels operate under maritime navigational rules requiring them to observe and avoid other vessels. In addition, NOTMARs advise vessel operators about when and where Navy training and testing activities are scheduled. Finally, Navy personnel are required to verify that the range is clear of nonparticipants before initiating any potentially hazardous activity. Similar knowledge and avoidance of popular fishing areas, such as the Galvez and Santa Rosa banks, would minimize interactions between Navy training and testing activities and recreational and commercial fishing. Together, these procedures would minimize the potential for adverse interactions between Navy and nonparticipant vessels. The Navy's standard operating procedures ensure that private and commercial vessels traversing the Study Area during training or testing activities do not interact with Navy vessels, ordnance, or surface targets.

Recreational diving within the Study Area takes place primarily at known diving sites such as shipwrecks and reefs. The locations of these popular dive sites are well documented, dive boats are typically well marked, and diver-down flags are visible from a distance. As a result, ships conducting training or testing activities would easily avoid dive sites. Interactions between training and testing activities and recreational divers thus would be minimized, reducing the potential for collisions or ship strikes. Similar knowledge and avoidance of popular fishing areas would minimize interactions between training and testing activities and recreational fishing.

Commercial and recreational fishing activities could encounter military expended materials that could entangle fishing gear and pose a safety risk. The Navy would continue to recover targets at or near the surface that were used during training or testing to ensure they would not pose a collision risk. Unrecoverable pieces of military expended materials are typically small (such as sonobuoys), constructed of soft materials (such as target cardboard boxes or tethered target balloons), or intended to sink to the bottom after their useful function was completed, so they would not be a collision risk to civilian vessels or equipment. Thus, these targets do not pose a safety risk to individuals using the area for recreation because the public would not likely be exposed to these items before they sank to the seafloor.

As discussed in Section 3.1 (Sediments and Water Quality), a west coast study categorized types of marine debris collected by a trawler during a groundfish survey. Military expended materials were categorized as plastic, metal, fabric and fiber, and rubber comprising 7.4, 6.2, 13.2, and 4.7 percent of the total count of items collected, respectively. Military expended materials are items used during training and testing activities and may include non-explosive munitions and targets, and accessories related to the carriage or release of these items. They do not include military debris such as wreckage from World War II. The footprint of military expended materials in the Study Area is discussed in Section 3.3 (Marine Habitats). Given the small percentage of items in the survey that were military expended materials, it is unlikely the public would encounter military expended materials during recreational or commercial fishing activities in the Study Area.

Section 3.1 (Sediments and Water Quality) also discussed the low failure rates of munitions, which indicate that most munitions function as intended. While fishing activities may encounter undetonated ordnance lying on the ocean floor, such an encounter would be unlikely given the large size of the Study Area and because the density of munitions in the Study Area is low. The Army Corps of Engineers prescribes the following procedure if military munitions are encountered: recognize when you may have encountered a munition, retreat from the area without touching or disturbing the item, and report the item to local law enforcement by calling 911 or the U.S. Coast Guard.

The analysis focuses on the potential for a direct physical interaction with an aircraft, vessel, target, or expended training item. All proposed activities have some potential for a direct physical interaction that could pose a risk to public health or safety, so the following analysis is not activity specific. While some of the activities may not pose a potential for a direct physical interaction (like pierside activities), the platforms associated with the activity (aircraft, vessel, towed devices) could have a direct physical interaction that could pose a risk. The greatest potential for a physical interaction would be along the coast because of the high concentration there of public activities.

3.13.3.3.1 No Action Alternative

3.13.3.3.1.1 Training Activities

Under the No Action Alternative, training activities would continue at current levels and within current established locations. The potential for a direct physical interaction between the public and aircraft, vessels, targets, or expended materials would not change from existing conditions. The military implements strict operating procedures that protect public health and safety. These operating procedures include ensuring clearance of the area prior to commencing training activities.

The analysis indicates that public health and safety would not be affected by physical interactions with training activities, based on the military's implementation of strict operating procedures that protect public health and safety. These operating procedures include ensuring clearance of the area before commencing training activities involving physical interactions. Because of the military's safety procedures, the potential for training activities to impact public health and safety under the No Action Alternative would be negligible.

3.13.3.3.1.2 Testing Activities

Under the No Action Alternative, the Navy would continue conducting deep water sound propagation and temperature-sound velocity profiles of the water column in the Study Area (refer to Table 2.4-4 for a complete description). Research vessels, acoustic test sources, side scan sonars, ocean gliders, existing moored acoustic topographic array and distributed vertical line array, and other oceanographic data collection equipment are used to collect information. Under the No Action Alternative, this activity would continue within the Study Area. Because of the Navy's safety procedures and the relatively remote location of this testing activity, the potential for this testing activity to impact public health and safety from physical interactions would be negligible.

3.13.3.3.2 Alternative 1

3.13.3.3.2.1 Training Activities

Under Alternative 1, the number of training activities would increase but would continue within established locations. However, the increased number of aircraft and vessel movements or use of targets and expended materials would be conducted under the same safety and inspection procedures as under the No Action Alternative. While Alternative 1 would adjust locations and tempo of training activities, the military would continue to implement standard operating and safety procedures; therefore, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be negligible.

3.13.3.3.2.2 Testing Activities

Under Alternative 1, proposed testing activities involving aircraft and vessel movement or use of targets and expended materials would be conducted under the same safety and inspection procedures during training. Because the potential for a physical interaction is not activity-specific or location-specific, the analysis for the training activities above applies to testing activities under Alternative 1. As concluded above, because of the military's safety procedures, the potential for testing activities to impact public health and safety under Alternative 1 would be negligible.

3.13.3.3.3 Alternative 2

3.13.3.3.3.1 Training Activities

Under Alternative 2, the number of training activities would increase. The potential for a direct physical interaction between the public and aircraft, vessels, targets, or expended materials would also increase.

While Alternative 2 would adjust locations and tempo of training activities, the military would continue to implementate standard operating and safety procedures; therefore, the potential for impacts on public health and safety beyond those identified under the No Action Alternative would be negligible.

3.13.3.3.3.2 Testing Activities

The potential for a physical interaction is not activity-specific or location-specific, so the analysis for the training activities above applies to testing activities under Alternative 2. As concluded above, because of the Navy's safety procedures, the potential for testing activities to impact public health and safety under Alternative 2 would be negligible.

3.13.3.4 Secondary Impacts

Public health and safety could be impacted if sediment or water quality were degraded. Section 3.1 (Sediments and Water Quality) considered the impacts on marine sediments and water quality of explosions and explosive byproducts, metals, chemicals other than explosives, and other materials (marine markers, flares, chaff, targets, and miscellaneous components of other materials). The analysis determined that no Guam, CNMI, or federal standards or guidelines would be violated by the No Action Alternative, Alternative 1, or Alternative 2. Because these standards and guidelines are structured to protect human health, and the proposed activities do not violate them, no secondary impacts on public health and safety would result from the training and testing activities proposed under the No Action Alternative, Alternative 1, or Alternative 2.

3.13.4 Summary of Potential Impacts (Combined Impacts of All Stressors) on Public Health and Safety

Activities described in this EIS/OEIS that could affect public health or safety include those that release underwater energy, in-air energy, or physical interactions, or that have indirect impacts from changes in sediment or water quality. Under the No Action Alternative, Alternative 1, or Alternative 2, these activities would be widely dispersed throughout the Study Area. Such activities also are dispersed temporally (i.e., few stressors would be present at the same time). For these reasons, no greater impacts from the combined operation of more than one stressor are expected. The aggregate impact on public health and safety would not observably differ.

REFERENCES

Professional Association of Diving Instructors. (2011). Scuba certification F.A.Q. Retrieved from http://www.padi.com/scuba/scuba-diving-guide/start-scuba-diving/scuba-certification-faq/default.aspx, 2011, March 8.

U.S. Department of Defense. (1981). Department of Defense Directive 4540.1 Use of Airspace by U.S. Military Aircraft and Firings Over the High Seas. In D. o. Defense (Ed.) (pp. 2). Washington, D.C.U.S. Department of Defense. (2002). *Electromagnetic environmental effects: Requirements for systems*. (MIL-STD-464A).

U.S. Department of Defense. (2009a). Department of Defense Instruction 6055.11 Protecting Personnel from Electromagnetic Fields. In U. S. D. o. Defense (Ed.) (pp. 12). Washington, D.C.

U.S. Department of Defense. (2009b). *Protecting personnel from electromagnetic fields*. (DODINST 6055.11).

U.S. Department of Defense. (2012). Bird/Animal Aircraft Strike Hazard. Department of Defense – Partners in Flight. Retrieved from http://dodpif.org/groups/bash.php, January 18, 2012.

U.S. Department of the Navy. (2007). Airspace Procedures and Planning Manual *OPNAVINST 370.2J*.

U.S. Department of the Navy. (2008). OPNAVINST 5100.27B/Marine Corps Order 5104.1C Navy Laser Hazards Control Program. In U. S. D. o. t. Navy (Ed.). Washington, D.C.: Office of the Chief of Naval Operations and Headquarters United States Marine Corps.

U.S. Department of the Navy. (2010). Bird/Animal Aircraft Strike Hazard (BASH) Manual: CNIC Air Operations Program Director.

U.S. Department of the Navy. (2011a). Joint Region Marianas Instruction 3500.4A Marianas Training Manual. In J. R. Marianas (Ed.). Guam.

U.S. Department of the Navy. (2011b). *U.S. Navy Dive Manual*. (Vol. 1–5).

U.S. Department of Transportation Federal Aviation Adminstration. (2011). Order JO 7440.9V Air Traffic Organization Policy Airspace Designations and Reporting Points. Washington, D.C.

U.S. Department of Transportation Federal Aviation Administration. (2013). Air Traffic Organization Policy: Special Use Airspace Federal Aviation Administration (Ed.). (FAA Order JO 7400.8V).

This Page Intentionally Left Blank

4 Cumulative Impacts

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

There are no figures in this section.

4 CUMULATIVE IMPACTS

4.1 INTRODUCTION

The analysis of cumulative impacts (or cumulative effects)[1] presented in this section follows the requirements of the National Environmental Policy Act (NEPA) and Council on Environmental Quality guidance (Council on Environmental Quality 1997). The Council on Environmental Quality regulations (40 Code of Federal Regulations [C.F.R.] §§1500-1508) provide the implementing regulations for NEPA. The regulations define cumulative impacts as

> "…the impact on the environment which results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 C.F.R. §1508.7)."

While a single project may have minor impacts, overall impacts may be collectively significant when the project is considered together with other projects on a regional scale. A cumulative impact is the additive effect of all projects in the geographic area. The Council on Environmental Quality provides guidance on cumulative impacts analysis in *Considering Cumulative Impacts under the National Environmental Policy Act* (Council on Environmental Quality 1997). This guidance further identifies cumulative impacts as those environmental impacts resulting "from spatial and temporal crowding of environmental perturbations. The impacts of human activities will accumulate when a second perturbation occurs at a site before the ecosystem can fully rebound from the impacts of the first perturbation." This guidance observes that "no universally accepted framework for cumulative impacts analysis exists" while noting that certain general principles have gained acceptance. The Council on Environmental Quality provides guidance on the extent to which agencies of the federal government are required to analyze the environmental impacts of past actions when they describe the cumulative environmental effect of an action. This guidance provides that an analysis of cumulative impacts might encompass geographic boundaries beyond the immediate area of an action and a timeframe that includes past actions and foreseeable future actions. Thus, the Council on Environmental Quality guidelines observe, "[it] is not practical to analyze cumulative impacts of an action on the universe; the list of environmental impacts must focus on those that are truly meaningful."

4.2 APPROACH TO ANALYSIS

4.2.1 OVERVIEW

Cumulative impacts were analyzed for each resource addressed in Chapter 3 (Affected Environment and Environmental Consequences) for the No Action Alternative, Alternative 1, and Alternative 2 (the alternatives) in combination with past, present, and reasonably foreseeable future actions. The cumulative impacts analysis included the following steps, described in more detail below:

1. Identify appropriate level of analysis for each resource.
2. Define the geographic boundaries and timeframe for the cumulative impacts analysis.
3. Describe current resource conditions and trends.
4. Identify potential impacts of each alternative that might contribute to cumulative impacts.

[1] Council on Environmental Quality Regulations provides that the terms "cumulative effects" and "cumulative impacts" are synonymous (40 C.F.R. §1508.8[b]); the terms are used interchangeably by various sources, but the term "cumulative impacts" is used in this document except for quotations, for continuity.

5. Identify past, present, and other reasonably foreseeable future actions that affect each resource.
6. Analyze potential cumulative impacts.

4.2.2 Identify Appropriate Level of Analysis for Each Resource

In accordance with Council on Environmental Quality guidance (Council on Environmental Quality 1997), the cumulative impacts analysis focused on impacts that are "truly meaningful." The level of analysis for each resource was commensurate with the intensity of the impacts identified in Chapter 3 (Affected Environment and Environmental Consequences). The rationale for the level of analysis applied to each resource is described in Section 4.4 (Resource-Specific Cumulative Impacts).

4.2.3 Define the Geographic Boundaries and Timeframe for Analysis

The geographic boundary for the cumulative impacts analysis includes, but is not limited to, the entire Mariana Islands Training and Testing (MITT) Study Area (Study Area) (Figure 2.1-1). The geographic boundaries for marine mammals and sea turtles were expanded to include activities outside the MITT Study Area that might impact migratory animals. Primary considerations from outside the Study Area include impacts associated with maritime traffic (e.g., vessel strikes and underwater noise) and commercial fishing (e.g., bycatch and entanglement).

Determining the timeframe for the cumulative impacts analysis requires estimating the length of time the impacts of the Proposed Action would last (Council on Environmental Quality 1997) and considering the specific resource in terms of its history of degradation. The Proposed Action includes ongoing and anticipated future training and testing activities. While the United States (U.S.) Department of the Navy (Navy) training and testing requirements change over time in response to world events and several other factors, the general types of activities addressed by this Environmental Impact Statement (EIS)/Overseas EIS (OEIS) are expected to continue indefinitely, and the associated impacts would occur indefinitely. Likewise, some reasonably foreseeable future actions and other environmental considerations addressed in the cumulative impacts analysis are expected to continue indefinitely (e.g., oil and gas production, maritime traffic, commercial fishing). Therefore, the cumulative impacts analysis is not bounded by a specific future timeframe. For past actions, the cumulative impacts analysis only considers those actions or activities that have ongoing impacts.

While the cumulative impacts analysis is not limited by a specific timeframe, it should be recognized that available information, uncertainties, and other practical constraints limit the ability to analyze cumulative impacts for the indefinite future. Navy environmental planning and compliance for training and testing activities is an ongoing process. The Navy intends to submit applications to the National Marine Fisheries Service (NMFS) for Marine Mammal Protection Act (MMPA) authorizations supported by this EIS/OEIS. The anticipated effective dates for these MMPA authorizations would be a 5-year period from May 2015 through April 2020. Future environmental planning documents will include cumulative impacts analysis based on information available at that time.

4.2.4 Describe Current Resource Conditions and Trends

The Affected Environment sections of Chapter 3 (Affected Environment and Environmental Consequences) describe current resource conditions and trends; these sections also discuss how past and present human activities influence each resource. The current aggregate impacts of past and present actions are reflected in the baseline information presented in Chapter 3 (Affected Environment and Environmental Consequences). This information is used in the cumulative impacts analysis to understand how past and present actions are currently impacting each resource and to provide the context for the cumulative impacts analysis.

4.2.5 Identify Potential Impacts of the Preferred Alternative That Might Contribute to Cumulative Impacts

Direct and indirect impacts of the alternatives, presented in Chapter 3 (Affected Environment and Environmental Consequences), were reviewed to identify impacts relevant to the cumulative impacts analysis. Key factors considered included the current status and sensitivity of the resource and the intensity, duration, and spatial extent of the impacts for each stressor. In general, long-term rather than short-term impacts and widespread rather than localized impacts were considered more likely to contribute to cumulative impacts. For example, for biological resources, population-level impacts were considered more likely to contribute to cumulative impacts than were individual-level impacts. Negligible impacts were not considered further in the cumulative impacts analysis. For marine mammals, any stressor that is expected to result in Level A harassment or Level B harassment, as defined by MMPA, was considered in the cumulative impacts analysis. For Endangered Species Act (ESA)-listed species, any stressor that may affect and is likely to adversely affect the species was considered in the cumulative impacts analysis. Stressors that were determined by the Navy to have no effect or that may affect but are not likely to adversely affect ESA-listed species were not analyzed in detail in the cumulative impacts analysis. A determination of may affect, not likely to adversely affect indicates that the impacts would be discountable (extremely unlikely) or insignificant.

4.2.6 Identify Other Actions and Other Environmental Considerations That Affect Each Resource

A list of other actions was compiled for the Study Area and surrounding areas based on information obtained during the scoping process (Appendix E, Public Participation), communications with other agencies, a review of other military activities, literature review, previous NEPA analyses for some of the other actions, and other available information. Identified future actions were reviewed to determine if they should be considered further in the cumulative impacts analysis. Factors considered when identifying other actions to be included in the cumulative impacts analysis included the following:

- Whether the other action is likely or probable (i.e., reasonably foreseeable), rather than merely possible or speculative.
- The timing and location of the other action in relationship to proposed training and testing activities.
- Whether the other action and the preferred alternative would affect the same resources.
- The current conditions, trends, and vulnerability of resources affected by the other action.
- The duration and intensity of the impacts of the other action.
- Whether the impacts have been truly meaningful, historically significant, or identified previously as a cumulative impact concern.

In addition to identifying reasonably foreseeable future actions, other environmental considerations for the cumulative impacts analysis were identified and described. These other considerations include major environmental stressors or issues (e.g., ocean pollution, ocean noise, coastal development, etc.) that tend to be widespread and arise from routine human activities and multiple past, present, and future actions. Including these other environmental considerations allows an analysis of the current aggregate impacts of past and present actions, as well as reasonably foreseeable actions.

4.2.7 Analyze Potential Cumulative Impacts

The current impacts of past and present actions and the anticipated impacts of reasonably foreseeable future actions were characterized and summarized. The incremental impacts of each alternative were then added to the combined impacts of all other actions to describe the cumulative impacts that would result if the No Action Alternative, Alternative 1, or Alternative 2 were implemented. The cumulative impacts analysis considered additive, synergistic, and antagonistic impacts. A qualitative analysis was conducted in cases based on the available information. The analysis in Chapter 3 (Affected Environment and Environmental Consequences) indicates that the direct and indirect impacts of the No Action Alternative, Alternative 1, and Alternative 2 would be similar for many of the stressors. Therefore, much of the cumulative impacts discussion applies to all three alternatives. Specific differences between the alternatives are discussed when appropriate.

4.3 Other Actions Analyzed in the Cumulative Impacts Analysis

4.3.1 Overview

Table 4.3-1 lists the other actions and other environmental considerations identified for the cumulative impacts analysis. Descriptions of each action and environmental consideration carried forward for analysis are provided in the following sections.

4.3.2 Oil and Natural Gas Exploration, Extraction, and Production

4.3.2.1 Oil Pipeline

The Commonwealth Utilities Corporation is planning on constructing an 8-inch (20.3-centimeter) aboveground receiving pipeline that delivers fuel to the Commonwealth Utilities Corporation power plants 1 and 2 in Lower Base from the Mobile Oil Facility. This facility is located on the central western coast of Saipan. The design is complete and construction began in March 2012.

4.3.2.2 Seismic Surveys

Seismic surveys are typically accomplished by towing a sound source such as an airgun array that emits acoustic energy in timed intervals behind a research vessel. The transmitted acoustic energy is reflected and received by an array of hydrophones. This acoustic information is processed to provide information about geological structure below the seafloor. The oil and gas industry uses seismic surveys to search for new hydrocarbon deposits. In addition, academic geologists use them to study plate tectonics and other topics. The underwater sound produced by these surveys could affect marine life, including marine mammals. For example, the potential exists to expose some animals to sound levels exceeding 180 decibels (dB) referenced to (re) 1 micropascal (μPa) root mean square, which would, in turn, potentially allow temporary or permanent loss of hearing (Bureau of Ocean Energy Management 2011a). All seismic surveys conducted by U.S. vessels are subject to the MMPA authorization process administered by the NMFS, as well as the NEPA process associated with issuing MMPA authorizations. Currently, there are several MMPA authorizations for seismic surveys near the Study Area, including one for the territorial waters of the Commonwealth of the Northern Mariana Islands (CNMI).

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis

#	Name of Action	Lead Agency or Proponent	Marine or Terrestrial	Timeframe	Retained for Further Analysis?
Oil and Natural Gas Exploration, Extraction, Production, and Offshore Energy Generation					
1	Oil pipeline construction	Commonwealth Utilities Corporation	Terrestrial	Present	Retained.
2	Seismic surveys	Bureau of Ocean Energy Management, oil and gas industry, National Science Foundation, and academic institutions	Marine	Past, present, and future	Retained.
3	Wave and tidal energy plants	Bureau of Ocean Energy Management	Marine	Future	Dismissed because action is speculative.
Port Improvements, Dredge Disposal, Beach Nourishment, and Mining					
4	Offshore dredge disposal program	U.S. Army Corps of Engineers, U.S. Environmental Protection Agency	Marine	Past, present, and future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
5	New Landfill Dandan	Department of Public Works	Terrestrial	Future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
6	Pagan Mining	CNMI Government Administration	Terrestrial	Past, present, and future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
7	Relocation of Landfill	Department of Public Works	Terrestrial	Present and future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
8	Deep Seabed Minerals Project	Nauru Ocean Resources	Marine	Future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
9	Commercial Port Improvements East of Hotel Wharf	Port Authority of Guam	Marine	Future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
10	Harbor Rehabilitation Project	Commonwealth Ports Authority	Marine	Present	Dismissed because action only pertains to improvements on existing structures.
Other Military Activities					
11	Army and Air Force Exchange Service on Saipan	Department of Defense	Terrestrial	Past	Retained.
12	Live Fire Training Range Complex on Guam	U.S. Navy	Terrestrial	Future	Retained.

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis (continued)

#	Name of Action	Lead Agency or Proponent	Marine or Terrestrial	Timeframe	Retained for Further Analysis?
Other Military Activities (continued)					
13	Surveillance Towed Array Sensor System Low Frequency Active Sonar	U.S. Navy	Marine	Past, present, and future	Retained.
14	Facility and Infrastructure Construction throughout Guam and CNMI	Department of Defense	Terrestrial	Future	Retained.
15	Portable Joint Threat Emitter in Mariana Islands Range Complex	Department of Defense	Terrestrial	Future	Retained.
16	Wind Turbines	Naval Facilities Engineering Command	Terrestrial	Future	Dismissed because action is pending approval and funding, specific future actions are speculative.
17	Divert Activities and Exercises	U.S. Air Force	Terrestrial	Future	Retained.
Environmental Regulations and Planning					
18	Draft Safe Harbor Agreement	U.S. Fish and Wildlife Service	Marine	Past, present, and Future	Dismissed because action involves only planning and policy-related activities; specific future actions are speculative.
19	Coastal and marine spatial planning	Regional Ocean Commissions	Marine	Future	Dismissed because action involves only planning and policy-related activities (see Chapter 6, Additional Regulatory Considerations).
20	Marine Mammal Protection Act incidental take authorizations	National Marine Fisheries Service	Marine	Past, present, and future	Retained.
21	5-year review of species under the Federal Endangered Species Act	U.S. Fish and Wildlife Service	Marine and Terrestrial	Past, present, and future	Dismissed because action involves only planning and policy-related activities; specific future actions are speculative.
22	Avian and Avifauna Conservation Plans	Not applicable	Terrestrial	Past, present and future	Dismissed because action involves only planning and policy-related activities; specific future actions are speculative.

Table 4.3-1: Other Actions and Other Environmental Considerations Identified for the Cumulative Impacts Analysis (continued)

#	Name of Action	Lead Agency or Proponent	Marine or Terrestrial	Timeframe	Retained for Further Analysis?
Environmental Regulations and Planning (continued)					
23	Reforestation of Masso Reservoir	GovGuam and U.S. Navy	Terrestrial	Past, present, and future	Dismissed because of negligible minor impacts on resources impacted by the Proposed Action.
Other Environmental Considerations					
24	Commercial fishing and fishery management plans	National Marine Fisheries Service and private industry	Marine	Past, present, and future	Retained.
25	Maritime traffic	Not applicable	Marine	Past, present, and future	Retained.
26	Development of Coastal Lands	Not applicable	Marine and terrestrial	Past, present, and future	Retained.
27	Ocean noise	Not applicable	Marine	Past, present, and future	Retained.
28	Ocean pollution (including marine debris, nonpoint source pollution, and cruise ship discharges)	Not applicable	Marine	Past, present, and future	Retained.
29	Commercial and general aviation	Not applicable	Marine and Terrestrial	Past, present, and future	Retained from greenhouse gas emission analysis.
30	Transportation Improvements	Not applicable	Marine and Terrestrial	Past, present, and future	Retained.
31	Climate Change	Not applicable	Marine and Terrestrial	Past, present, and future	Retained.

Notes: CNMI = Commonwealth of the Northern Mariana Islands, U.S. = United States

4.3.3 Other Military Actions

4.3.3.1 Army and Air Force Exchange Service on Saipan

In September 2008, the Army and Air Force Exchange Service opened a 181,000-square-foot (ft.^{2}) (16,815.4-square-meter [m^2]) Shopping Complex on Andersen Air Force Base. This facility has 81,000 ft.^{2} (7,525.1 m^2) of retail space, which is triple the size of the old Exchange.

4.3.3.2 Live Fire Training Range Complex on Guam

In February 2012, the Navy initiated a Supplemental EIS to evaluate the environmental consequences of establishing a live-fire training range complex on Guam in support of the relocation of Marine Corps forces to Guam. Scoping meetings for the Supplemental EIS were held in March 2012. On 27 April 2012, the U.S.-Japan Security Consultative Committee issued a joint statement announcing its decision to adjust the plans outlined in the May 2006 Realignment Roadmap document. In accordance with the adjustments (the "2012 Roadmap Adjustments"), the Department of Defense adopted a new force posture in the Pacific which provided a substantially smaller Marine Corps relocation to Guam. As a result of the 2012 Roadmap Adjustments, the Navy expanded the scope of the Supplemental EIS to also evaluate the potential environmental consequences from construction and operation of a main cantonment area, including family housing, and associated infrastructure to support the relocation of a substantially reduced number of Marines than previously analyzed. The Supplemental EIS supplements the 2010 Final EIS for the Guam and CNMI Military Relocation.

4.3.3.3 Surveillance Towed Array Sensor System Low Frequency Active Sonar

In August 2012, the Navy released a Record of Decision for employing the Surveillance Towed Array Sensor System Low Frequency Active Sonar. The Navy currently plans to operate up to four Surveillance Towed Array Sensor System Low Frequency Active Sonar systems for routine training, testing, and military operations. Based on current Navy national security and operational requirements, routine training, testing, and military operations using these sonar systems could occur in the Pacific Ocean (including the Study Area), Atlantic Ocean, Indian Ocean, and Mediterranean Sea.

4.3.3.4 Facility and Infrastructure Construction throughout Guam and the Commonwealth of the Northern Mariana Islands

Facility and Infrastructure construction throughout Guam and CNMI involves components from the U.S. Marine Corps, the Navy, and the U.S. Army. These are the main components for this Proposed Action:

- **Guam and CNMI Military Relocation.** Develop and construct facilities and infrastructure within Guam and the CNMI to meet the Marine Corps' living, training, and readiness requirements. Relocate approximately 5,000 Marines and their dependents from Okinawa to the Mariana Islands while concurrently increasing the civilian workforce. This action is analyzed in the Supplemental EIS for the Live Fire Training Range Complex on Guam discussed in Section 4.3.3.2 (Live Fire Training Range Complex on Guam).
- **CNMI Joint Military Training.** Establish ranges and training areas in the Western Pacific to meet the consolidated unfilled training requirements of the Service Components. The Notice of Intent to complete an EIS/OEIS was published in the Federal Register on 14 March 2013.
- **CVN Supplemental National Environmental Policy Act Analysis.** Construct a new deep-draft wharf with shore side infrastructure improvements creating the capability to support a transient nuclear aircraft carrier and carrier strike group in Apra Harbor, Guam.

- **X-Ray Wharf Environmental Assessment (EA).** Construction of improvements to the existing main supply wharf within Naval Base Guam to accommodate two berths for the Navy's new class of supply ships. The Final EA is anticipated in spring 2014.
- **Army.** Develop facilities and infrastructure on Guam to allow an Army Air and Missile Defense Task Force to protect Guam from potential ballistic missile attacks. Relocate approximately 600 military personnel, 900 dependents, and 100 civilian support workforces to Guam.

4.3.3.5 Portable Joint Threat Emitter in the Mariana Islands Range Complex

The Joint Threat Emitter is owned by the U.S. Navy and provides realistic threat simulations in the training environment. The primary location for the Joint Threat Emitter is planned for placement and use in Ritidian Point at Andersen Air Force Base. The Finding of No Significant Impact for the Environmental Assessment was signed on 31 July 2012.

4.3.3.6 Divert Activities and Exercises

The U.S. Air Force proposes improvements to an existing airfield on U.S. territory near the Philippine Sea in support of expanding mission requirements in the western Pacific. In addition, divert capabilities for current, emerging, and future training activities are proposed. A Draft EIS analyzing environmental impacts associated with the divert activities and exercises was published in June 2012.

4.3.4 Environmental Regulations and Planning

4.3.4.1 Coastal and Marine Spatial Planning

Dismissed because action involves only planning and policy-related activities (discussed in Chapter 6, Additional Regulatory Considerations).

4.3.4.2 Marine Mammal Protection Act Incidental Take Authorizations

The MMPA generally prohibits "take" of marine mammals in U.S. waters by any person and by U.S. citizens in international waters. The National Marine Fisheries Service can authorize "take" for specific activities.

4.3.5 Other Environmental Considerations

4.3.5.1 Commercial Fishing

Commercial fishing constitutes an important and widespread use of the ocean resources throughout the Study Area. Commercial fishing can adversely affect fish populations, other species, and habitats. Potential impacts of commercial fishing include overfishing of targeted species and bycatch, both of which negatively affect fish stocks and other marine resources. Bycatch is the capture of fish, marine mammals, sea turtles, marine birds, and other nontargeted species that occurs incidental to normal fishing operations. Use of mobile fishing gear, such as bottom trawls, disturbs the seafloor and reduces structural complexity. Indirect impacts of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris. Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats and have the potential to entangle or be ingested by marine mammals.

Commercial fishing can have a profound influence on individual fish populations. In a study of retrospective data, Jackson et al. (2001) analyzed paleoecological records of marine sediments from 125,000 years ago to present, archaeological records from 10,000 years before the present, historical documents, and ecological records from scientific literature sources over the past century. Examining this longer-term data and information, Jackson et al. (2001) concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance of coastal ecosystems, including pollution and anthropogenic climatic change. Fisheries bycatch has been identified as a primary driver of population declines in several groups of marine species, including sharks, mammals, marine birds, and sea turtles (Wallace et al. 2010).

4.3.5.2 Maritime Traffic

Portions of the Study Area are heavily traveled by commercial, recreational, and government marine vessels, with several commercial ports occurring in or near the Study Area. Section 3.12 (Socioeconomic Resources) provides additional information for marine vessel traffic in the Study Area. Primary concerns for the cumulative impacts analysis include vessels striking marine mammals and sea turtles, introduction of non-native species through ballast water, and underwater sound from ships and other vessels.

4.3.5.3 Development of Coastal Lands

Coastal development intensifies use of coastal resources, resulting in potential impacts on water quality, marine habitat, and air quality. Coastal land development in the Study Area is both intensive and extensive. Development continues to impact coastal resources through point and nonpoint source pollution, concentrated recreational use, and intensive ship traffic using major port facilities. The Study Area coastline also includes coastal tourism development (e.g., hotels, resorts, restaurants, food industry, vacation homes, second homes) and the infrastructure supporting coastal development (e.g., retail businesses, marinas, fishing tackle stores, dive shops, fishing piers, recreational boating harbors, beaches, recreational fishing facilities).

Coastal development is regulated by states and territories through the Coastal Zone Management Act and associated state and local programs. Chapter 6 (Additional Regulatory Considerations) provides additional information on coastal zone management in the Study Area.

4.3.5.4 Ocean Noise

Anthropogenic sources of noise that are most likely to contribute to increases in ocean noise are vessel noise from commercial shipping and general vessel traffic, oceanographic research, oil and gas exploration, underwater construction, and naval and other use of sound navigation and ranging.

Any potential for cumulative impact should be put into the context of recent changes to ambient sound levels in the world's oceans as a result of anthropogenic activities. However, there is a large and variable natural component to the ambient noise level as a result of events such as earthquakes, rainfall, waves breaking, and lightning hitting the ocean as well as biological noises such as those from snapping shrimp and the vocalizations of marine mammals.

Andrew et al. (2002) compared ocean ambient sound from the 1960s to the 1990s from a receiver off the California coast. The data showed an increase in ambient noise of approximately 10 dB in the frequency ranges of 20 to 80 Hertz (Hz) and 200 to 300 Hz, and about 3 dB at 100 Hz over a 33-year period. Each 3 dB increase is noticeable to the human ear and a doubling in sound level. A possible explanation for the rise in ambient noise is the increase in shipping noise. There are approximately 11,000 supertankers worldwide, each operating 300 days per year, producing constant broadband noise at source levels of 198 dB (Hildebrand 2004). Generally the most energetic regularly operated sound sources are seismic airgun arrays from approximately 90 vessels with typically 12 to 48 individual guns per array, firing about every 10 seconds (Hildebrand 2004).

Appendix I (Acoustic and Explosives Primer) provides additional information about sources of anthropogenic sound in the ocean and other background information about underwater noise. This section describes the different types of effects that are possible and the potential relationships between sound stimuli and long-term consequences for individual animals and populations. A variety of impacts may result from exposure to sound-producing activities. The severity of these impacts can vary greatly between minor impacts that have no real cost to the animal, to more severe impacts that may have lasting consequences. The major categories of potential impacts are: behavioral reactions, physiological stress, auditory fatigue, auditory masking, and direct trauma.

4.3.5.5 Ocean Pollution

Pollution is the introduction of harmful contaminants that are outside the norm for a given ecosystem. Ocean pollution has and will continue to have serious impacts on marine ecosystems. Common ocean pollutants include toxic compounds such as metals, pesticides, and other organic chemicals; excess nutrients from fertilizers and sewage; detergents; oil; plastics; and other solids. Pollutants enter oceans from nonpoint sources (e.g., storm water runoff from watersheds), point sources (e.g., wastewater treatment plant discharges), other land-based sources (e.g., windblown debris), spills, dumping, vessels, and atmospheric deposition.

4.3.5.5.1 Non-Point Sources, Point Sources, and Atmospheric Deposition

Polluted runoff, or non-point source pollution, is considered the major cause of impairment of ocean waters. Stormwater runoff from coastal urban areas and beaches carries waste such as plastics and Styrofoam into coastal waters. Sewer outfalls are a point source type of ocean pollution. Sewage can be treated to eliminate potentially harmful releases of contaminants; however, releases of untreated sewage occur due to malfunctions or overloads to the infrastructure, resulting in releases of bacteria usually associated with feces, such as *Escherichia coli* and *Enterococci spp*. Bacteria levels are used routinely to determine the quality of water at recreational beaches and as indicators of the possible presence of other harmful microorganisms. In the past, toxic chemicals have been released into sewer systems. While such dumping has long been forbidden by law, the practice left ocean outflow sites contaminated. Sewage treatment facilities generally do not treat or remove persistent organic pollutants, such as polychlorinated biphenyl (PCB) and dichlorodiphenyltrichloroethane (DDT), or other toxins.

Hypoxia (low dissolved oxygen concentration) is a major impact associated with point and non-point sources of pollution. Hypoxia occurs when waters become overloaded with nutrients such as nitrogen and phosphorus, which enter oceans from non-point source runoff, wastewater treatment plants, and atmospheric deposition. Too many nutrients can stimulate algal blooms—the rapid expansion of microscopic algae (phytoplankton). When excess nutrients are consumed, the algae population dies off and the remains are consumed by bacteria. Bacterial consumption causes dissolved oxygen in the water to decline to the point where marine life that depends on oxygen can no longer survive (Boesch et al. 1997). Harmful algal blooms are proliferations of marine and freshwater algae (including cyanobacteria and non-photosynthetic algae-like organisms) that can produce toxins, causing human illness and massive animal mortalities. They also can accumulate in sufficient numbers to alter ecosystems in detrimental ways.

Non-point sources, point sources, and atmospheric deposition also contribute toxic pollutants such as metals, pesticides, and other organic compounds to the marine environment. Toxic pollutants may cause lethal or sublethal effects if present in high concentrations, and can build up in tissues over time and suppress immune system function, resulting in disease and death.

4.3.5.5.2 Marine Debris

Marine debris is any anthropogenic object intentionally or unintentionally discarded, disposed of, or abandoned that enters the marine environment (National Marine Fisheries Service 2006). Common types of marine debris include various forms of plastic and abandoned fishing gear. Marine debris degrades marine habitat quality and poses ingestion and entanglement risks to marine life and birds (National Marine Fisheries Service 2006).

Plastic debris is a major concern because it degrades slowly and many plastics float. The floating debris is transported by currents throughout the oceans and has been discovered accumulating in oceanic gyres (Law et al. 2010). Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as PCB and DDT, which accumulate up to one million times more in plastic than in ocean water (Takada et al. 2001). Fish, marine animals, and birds can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. In the North Pacific Subtropical Gyre it is estimated that the fishes in this area are ingesting 12,000 to 24,000 U.S. tons (10,886,216 to 21,772,433 kilograms [kg]) of plastic debris a year (Davison and Asch 2011).

4.3.5.6 Commercial and General Aviation

Commercial and general aviation are retained for analysis and discussion due to associated emissions from aviation activities and effects on greenhouse gas. An analysis of greenhouse gas is presented in Section 4.4.3.1 (Greenhouse Gases).

4.3.5.7 Transportation Improvements

Saipan Department of Public Works Route 1 Feasibility Study will look into the prospect of passenger and vehicle ferry services between Tinian and Saipan. Service had formerly been provided between the two islands but was suspended in March 2010 due to a need for repairs. The Feasibility Study is needed to prove the economic benefits of the passenger and vehicle ferry services between the two islands and to determine any environmental impacts (Saipan Tribune 2012a).

4.3.5.8 Climate Change

The Intergovernmental Panel on Climate Change (2007) reports that physical and biological systems on all continents and in most oceans are already being affected by recent climate changes. Global-scale assessment of observed changes shows that it is likely that anthropogenic warming over the last three decades has had a discernible influence on many physical and biological systems. Some of the major potential concerns for the marine environment include:

- Sea temperature rise
- Melting of polar ice
- Rising sea levels
- Changes to major ocean current systems
- Ocean acidification

4.4 RESOURCE-SPECIFIC CUMULATIVE IMPACTS

4.4.1 RESOURCE AREAS DISMISSED FROM CURRENT IMPACTS ANALYSIS

In accordance with Council on Environmental Quality guidance (Council on Environmental Quality 2010), the cumulative impacts analysis focused on impacts that are "truly meaningful." The level of analysis for each resource was commensurate with the intensity of the impacts identified in Chapter 3 (Affected Environment and Environmental Consequences). The analysis focused on marine mammals, sea turtles, terrestrial species and habitats, and cultural resources. While each of the following resources is discussed in the following section, detailed analysis of cumulative impacts was not necessary for the following resources as the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low. Further analysis of cumulative impacts is not warranted on the following resources:

- Sediments and water quality
- Air quality
- Marine habitats
- Marine birds
- Marine vegetation
- Marine invertebrates
- Fish
- Socioeconomic resources
- Public health and safety

4.4.2 SEDIMENTS AND WATER QUALITY

The analysis in Section 3.1 (Sediments and Water Quality) indicates that the Preferred Alternative could result in local, short- and long-term changes in sediment and water quality. However, chemical, physical, or biological changes to sediments or water quality would be below applicable standards, regulations, and guidelines and would be within existing conditions or designated uses (Section 3.1.1.2, Methods, lists applicable standards, regulations, and guidelines). The short-term impacts would arise from explosions and the byproducts of explosions and combusted propellants. It is unlikely these short-term impacts would overlap in time and space with other future actions that produce similar constituents. Therefore, the short-term impacts described in Section 3.1 (Sediments and Water Quality) are not expected to contribute to cumulative impacts.

The long-term impacts would arise from unexploded ordnance, noncombusted propellant, metals, and other materials. Long-term impacts of each alternative would be cumulative with other actions that cause increases in similar constituents. However, the incremental contribution of the No Action Alternative, Alternative 1 (Preferred Alternative), or Alternative 2 to long-term cumulative impacts would be negligible because:

- Most training and testing activities are widely dispersed in space and time;
- Most components of expended materials are inert or corrode slowly;
- Numerically, most of the metals expended are small- and medium-caliber projectiles, metals of concern comprise a small portion of the alloys used in expended materials, and metal corrosion is a slow process that allows for dilution;
- Most of the components are subject to a variety of physical, chemical, and biological processes that render them benign; and

- Potential areas of impacts would be limited to small zones immediately adjacent to the explosive, metals, or chemicals other than explosives.

Furthermore, none of the alternatives would result in long-term and widespread changes in environmental conditions, such as nutrient loading, turbidity, salinity, or pH (a measure of the degree to which a solution is either acidic [pH less than 7.0] or basic [pH greater than 7.0]). Based on the analysis presented in Section 3.1 (Sediments and Water Quality) and the reasons summarized above, the changes in sediment and water quality would be measurable, but would still be below applicable standards and guidelines; therefore, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low and further analysis of cumulative impacts is not warranted.

4.4.3 AIR QUALITY

As detailed in Section 3.2 (Air Quality), training and testing activities conducted under Alternatives 1 and 2 would result in increased criteria pollutant emissions and hazardous air pollutant emissions throughout the Study Area. Sources of the emissions would include vessels and aircraft and, to a lesser extent, munitions. Potential impacts include localized and temporarily elevated pollutant concentrations. Recovery would occur quickly as emissions disperse. The impacts of Alternatives 1 or 2 would be cumulative with other actions that involve criteria air pollutant and hazardous air pollutant emissions. However, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be low for the following reasons:

- Most training and testing-related emissions are projected to occur at distances greater than 3 nautical miles (nm) from shore.
- Few stationary offshore air pollutant emission sources exist within the Study Area and few are expected in the foreseeable future.
- International regulations by the International Maritime Organization required commercial shipping vessels to switch to lower-sulfur fuel near U.S. and international coasts beginning in 2012 (National Oceanic and Atmospheric Administration 2011). The Department of Defense has released the *Operational Energy Strategy: Implementation Plan* which will reduce demand, diversify energy sources, and integrate energy consideration into planning (Department of Defense 2012). The U.S. Department of the Navy policy commits to a reduction of oil consumption by 50 percent by 2015; 40 percent of the Navy's total energy will come from fossil fuel alternatives and 50 percent of its onshore energy will come from renewable sources by 2020 (Environmental and Energy Study Institute 2009; Paige 2009).

Based on the analysis presented in Section 3.2 (Air Quality) and the reasons summarized above, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be negligible. Further analysis of cumulative impacts on air quality is not warranted.

4.4.3.1 Greenhouse Gases

Greenhouse gases are compounds that contribute to the greenhouse effect. The greenhouse effect is a natural phenomenon in which these gases trap heat within the surface-troposphere (lowest portion of the earth's atmosphere) system, causing heating (radiative forcing) at the surface of the earth. Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in greenhouse gas emissions from human activities (U.S. Environmental Protection Agency 2012). Without greenhouse gases the planet's surface would be about 60 degrees Fahrenheit (°F) cooler than present, according to the National Oceanic and Atmospheric Administration and National Aeronautics and Space

Administration data the average surface temperature has increase by about 1.2 to 1.4°F since 1900. If greenhouse gases continue to increase, models predict that the average temperature at the earth's surface could increase from 2.0 to 11.5°F above the 1990 levels by the end of this century (Le Treut et al. 2007).

Predictions of long-term negative environmental impacts due to global warming include sea level rise, changes in ocean pH and salinity, changing weather patterns with increases in the severity of storms and droughts, changes to local and regional ecosystems (including the potential loss of species), shrinking glaciers and sea ice, thawing permafrost, a longer growing season, and shifts in plant and animal ranges. Climate change is likely to negatively impact the Study Area and adjacent regions.

Over the next several decades, temperatures are projected to rise. The projected warming and more extensive climate-related changes could dramatically alter the region's economy, landscape, character, and quality of life (Le Treut et al. 2007).

In 2009, the U.S. generated about 6,633.2 teragrams (Tg) (or million metric tons) of carbon dioxide (CO_2) equivalents (U.S. Environmental Protection Agency 2012). The 2009 inventory data (U.S. Environmental Protection Agency 2012) show that CO_2, methane (CH_4), and nitrous oxide (N_2O) contributed from fossil fuel combustion processes of mobile and stationary sources (all sectors) include approximately:

- 5,505.2 Tg of CO_2
- 686.3 Tg CH_4
- 295.6 Tg N_2O

The 6,633.2 Tg CO_2 equivalent (CO_2 Eq) generated in 2009 is a decrease from the 7,263.4 Tg CO_2 Eq generated in 2007 (U.S. Environmental Protection Agency 2011). Among domestic transportation sources, light-duty vehicles (including passenger cars and light-duty trucks) represented 64 percent of CO_2 emissions, medium- and heavy-duty trucks 20 percent, commercial aircraft 6 percent, and other sources 9 percent. Across all categories of aviation, CO_2 emissions decreased by 21.6 percent (38.7 Tg) between 1990 and 2009. This includes a 59 percent (20.3 Tg) decrease in emission from domestic military operations. To place military aircraft in context with other aircraft CO_2 emissions, in 2009, commercial aircraft generated 111.4 Tg CO_2 Eq, military aircraft generated 14.1 Tg CO_2 Eq, and general aviation aircraft generated 13.3 Tg CO_2 Eq Military aircraft represent roughly 10 percent of emissions from the overall jet fuel combustion category (U.S. Environmental Protection Agency 2012).

This section begins by providing the background and regulatory framework for greenhouse gases. It then provides a quantitative evaluation of changes in greenhouse gas emissions that would occur under the Proposed Action and analyzes the cumulative impacts of greenhouse gas emissions.

4.4.3.1.1 Regulatory Framework

Federal agencies address emissions of greenhouse gases by reporting and meeting reductions mandated in laws, executive orders (EOs), and policies. The most recent of these are EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance* of 5 October 2009, and EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* of 26 January 2007.

Executive Order 13514 shifts the way the government operates by (1) establishing greenhouse gases as the integrating metric for tracking progress in federal sustainability, (2) requiring a deliberative planning process, and (3) linking budget allocations and Office of Management and Budget scorecards to ensure goal achievement.

The targets for reducing greenhouse gas emissions discussed in EO 13514 for Scope 1 (direct greenhouse gas emissions from sources that are owned or controlled by a federal agency) and Scope 2 (direct greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency) have been set for the Department of Defense at a 34 percent reduction of greenhouse gas from the 2008 baseline by 2020. Scope 3 targets (greenhouse gas emissions from sources not owned or directly controlled by a federal agency but related to agency activities such as vendor supply chains, delivery services, and employee travel and commuting) were set at a 13.5 percent reduction. EO 13514, *Strategic Sustainability Performance Plan*, submitted to the Council on Environmental Quality on 2 June 2010 contains a guide for meeting these goals.

Executive Order 13423 established a policy that federal agencies conduct their environmental, transportation, and energy-related activities in support of their respective missions in an environmentally economic way. It included a goal of improving energy efficiency and reducing greenhouse gas emissions of the agency through reduction of energy intensity by 3 percent annually through the end of Fiscal Year 2015, or 30 percent by the end of Fiscal Year 2015, relative to the baseline of the agency's energy use in fiscal year 2003.

The *Draft NEPA Guidance on Consideration of the Impacts of Climate Change and Greenhouse Gas Emissions* (Council on Environmental Quality 2010) states that "if a proposed action would be reasonably anticipated to cause direct emissions of 25,000 metric tons or more of carbon dioxide equivalent (CO_2 Eq) greenhouse gas emissions on an annual basis, agencies should consider this an indicator that a quantitative and qualitative assessment may be meaningful to decision makers and the public."

The Navy is committed to improving energy security and environmental stewardship by reducing reliance on fossil fuels. The Navy is actively developing and participating in energy, environmental, and climate change initiatives that will increase use of alternative energy and help conserve the world's resources for future generations. The Navy Climate Change Roadmap identifies actions the Environmental Readiness Division is taking to implement EO 13514 (U.S. Department of the Navy 2010). The Navy's Task Force Energy is responding to the Secretary of the Navy's energy goals through energy security initiatives that reduce the Navy's carbon footprint. The Climate Change Roadmap (5-year roadmap) action items, objectives, and desired impacts are organized to focus on strategies, policies and plans; operations and training; investments; strategic communications and outreach; and environmental assessment and prediction.

4.4.3.1.2 Cumulative Greenhouse Gas Impacts

Climate change is a global issue, and greenhouse gas emissions are a concern from a cumulative perspective because individual sources of greenhouse gas emissions are not large enough to have an appreciable impact on climate change. This greenhouse gas analysis considers the incremental contribution of Alternatives 1 and 2 to total estimated U.S. greenhouse emissions and their significance on climate change as compared to the No Action Alternative.

To estimate total greenhouse gas emissions, each greenhouse gas is assigned a global warming potential; that is, the ability of a gas or aerosol to trap heat in the atmosphere. The global warming potential rating system is standardized to CO_2, which has a value of 1. For example, CH_4 has a global warming potential of 21, which means that it has a global warming effect 21 times greater than CO_2 on an equal-mass basis (Intergovernmental Panel on Climate Change 2007). To simplify greenhouse gas analyses, total greenhouse gas emissions from a source are often expressed as CO_2 Eq. The CO_2 Eq is calculated by multiplying the emissions of each greenhouse gas by its global warming potential and adding the results together to produce a single, combined emission rate representing all greenhouse gases. While CH_4 and N_2O have much higher global warming potentials than CO_2, CO_2 is emitted in much higher quantities, so it is the overwhelming contributor to CO_2 Eq from both natural processes and human activities. Global warming potential-weighted emissions are presented in terms of equivalent emissions of CO_2, using units of Tg (1 million metric tons, or 1 billion kg) of Tg CO_2 Eq.

Greenhouse gas emissions were calculated for ships and aircraft (Table 4.4-1), which contribute the majority of emissions associated with training and testing in the Study Area. Greenhouse gas emissions from minor sources such as munitions, weapons platforms, and auxiliary equipment are considered negligible and were not calculated. Ship greenhouse gas emissions were estimated by determining annual ship fuel (typically diesel) use based on proposed activities and multiplying total annual ship fuel consumption by the corresponding emission factors for CO_2, CH_4, and N_2O. Aircraft greenhouse gas emissions were calculated by multiplying jet fuel use rates by the total operating hours, by the corresponding jet fuel emission factors for CO_2, CH_4, and N_2O, and by the total annual sorties.

Table 4.4-1: Greenhouse Gas Emissions from Ship and Aircraft Training and Testing Activities in the Mariana Islands Training and Testing Study Area

Alternative	Annual Emissions (Teragrams)			
	CO_2	N_2O	CH_4	CO_2 Eq
No Action Alternative	0.21	0.00	0.00	0.21
Alternative 1 (Preferred Alternative)	0.74	0.00	0.00	0.75
Increase in emissions for Alternative 1 compared to No Action Alternative	0.53	0.00	0.00	0.54
Alternative 2	0.81	0.00	0.00	0.82
Increase in emissions for Alternative 2 compared to No Action Alternative	0.60	0.00	0.00	0.61

Notes: CO_2 = carbon dioxide, N_2O = nitrous oxide, CH_4 = methane, CO_2 Eq = carbon dioxide equivalent

Ship and aircraft greenhouse gas emissions are compared to U.S. 2009 greenhouse gas emissions in Table 4.4-2; calculations are included in Appendix D (Air Quality Calculations and Record of Non-Applicability). The estimated CO_2 Eq emissions from the No Action Alternative are 0.0032 percent of the total CO_2 Eq emissions generated by the United States in 2009. The estimated CO_2 Eq emissions from Alternatives 1 and 2 would increase because of increased training and testing activities to about 0.0113 and 0.0124 percent of the total CO_2 Eq emissions, respectively, generated by the United States in 2009.

Based on the analysis presented in Section 3.2 (Air Quality) and the reasons summarized above, the changes in air quality would be measurable, but would still be below applicable standards and guidelines; therefore, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be low and further analysis of cumulative impacts is not warranted.

Table 4.4-2: Comparison of Ship and Aircraft Greenhouse Gas Emissions to United States 2009 Greenhouse Gas Emissions

Alternative	Annual Greenhouse Gas Emissions (CO_2 Eq)	Percentage of U.S. 2009 Greenhouse Gas Emissions
No Action Alternative	0.22	0.0032
Alternative 1 (Preferred Alternative)	0.72	0.0113
Alternative 2	0.81	0.0124
U.S. 2009 greenhouse gas emissions	6,633.2	

Note: CO_2 Eq = carbon dioxide equivalent
Source: U.S. Environmental Protection Agency 2011

4.4.4 Marine Habitats

The analysis presented in Section 3.3 (Marine Habitats) indicates that marine habitats could be affected by acoustic stressors (underwater detonations) and physical disturbance or strikes (interactions with military expended materials or seafloor devices). Potential impacts include localized disturbance of the seafloor, cratering of soft bottom sediments, and structural damage to hard bottom habitats. Impacts on soft bottom habitats would be short term, and impacts on hard bottom would be long term. The impacts of each alternative would be cumulative with other actions that cause similar disturbances. The current aggregate impacts of past, present, and reasonably foreseeable future actions described in Section 4.3 (Other Actions Analyzed in the Cumulative impacts Analysis) may have a significant effect, but are not likely to adversely affect marine habitats. These aggregate impacts are considered significant because vessel strikes, dredging, and other stressors associated with other actions discussed in Section 4.3 (Other Actions Analyzed in the Cumulative impacts Analysis) and Table 4.3-1 may result in alterations of marine habitats. Alternative 1 could also result in alterations of marine habitats from underwater explosions and strikes. Although this EIS/OEIS does address some of these other actions in Section 4.3 (Other Actions Analyzed in the Cumulative impacts Analysis), many of these other actions, and their cumulative impacts on marine habitats, cannot be determined with any specificity or certainty at this time. However, it can reasonably be assumed that there may be marine habitats that could be affected by these other actions, but with no specific details regarding the individual impacts or effects. Alterations to marine habitats that might occur under Alternative 1 would be additive to those associated with these other actions. However, the relative contribution of Alternative 1 to the overall alterations of marine habitats would be low compared to the other actions for the following reasons:

- The area of hard bottom potentially impacted represents a negligible percentage (less than 1 percent as analyzed in Section 3.3, Marine Habitats) of the total hard bottom habitat in the Study Area.
- Impacts would be confined to a limited area, and recovery of soft bottom habitats would occur quickly.

Based on the analysis presented in Section 3.3 (Marine Habitats) and the reasons summarized above, the incremental contribution of Alternatives 1 or 2 to cumulative impacts would be negligible.

4.4.5 Marine Mammals

4.4.5.1 Impacts of Alternatives 1 and 2 That May Contribute to Cumulative Impacts

Based on the analysis presented in Section 3.4 (Marine Mammals), impacts of Alternatives 1 and 2 that might contribute to cumulative impacts on marine mammals include mortality, injury (Level A harassment under the MMPA), and disturbance or behavioral modification (MMPA Level B harassment).

Mortality or injury could be caused by underwater explosions or vessel strikes. Injury, in the form of permanent threshold shift (PTS), could also be caused by sonar use. Underwater explosions, swimmer defense air guns, and sonar use would result in disturbance that meets the definition of MMPA Level A and B harassment. The remaining stressors analyzed in Section 3.4 (Marine Mammals) are not expected to result in mortality or Level A or B harassment. The incremental contribution of these remaining stressors to cumulative impacts on marine mammals would be negligible. These stressors are discussed in Section 4.4.5.2 (Impacts of Other Actions) below. The impacts of Alternatives 1 and 2 considered in the cumulative impacts analysis are summarized in Chapter 3, Section 3.4 (Marine Mammals).

4.4.5.2 Impacts of Other Actions

4.4.5.2.1 Overview

The potential impacts of other actions that are relevant to the cumulative impact analysis for marine mammals include the following:

- Mortality associated with vessel strikes, bycatch in fisheries, and entanglement in fishing and other gear
- Injury associated with vessel strikes, bycatch, entanglement, and underwater sound
- Disturbance, behavioral modifications, and reduced animal fitness associated with underwater noise
- Reduced animal fitness associated with water pollution

Most of the other actions and considerations retained for analysis in Table 4.3-1 would include operation of marine vessels. Exceptions include the actions listed under environmental regulations and planning. Stressors associated with marine vessel operations that are of primary concern for the cumulative impacts analysis includes vessel strikes and underwater noise. Many of the actions would also result in underwater noise from sources other than vessels, including use of explosives for oil rig removal, seismic surveys, and construction activities. Rather than discussing these stressors for individual actions, their aggregate impacts are considered below as “other environmental considerations” in the maritime traffic (Section 4.4.5.2.3) and ocean noise (Section 4.4.5.2.4) subsections. Similarly, many of the actions would result in water pollution. The aggregate impacts of water pollution are addressed below in the ocean pollution section (Section 4.4.5.2.5). Bycatch is associated with commercial fishing, and the primary cause of entanglement is commercial fishing. Therefore, these stressors are discussed below in the commercial fishing section (Section 4.4.5.2.7).

4.4.5.2.2 Surveillance Towed Array Sensor System Low Frequency Active Sonar

Potential impacts on marine mammals from Surveillance Towed Array Sensor System Low Frequency Active Sonar operations include (1) nonauditory injury, (2) permanent loss of hearing, (3) temporary loss of hearing, (4) behavioral change, and (5) masking. The potential effects from Surveillance Towed Array Sensor System Low Frequency Active Sonar operations on any stock of marine mammals from injury (nonauditory or permanent loss of hearing) are considered negligible, and the potential effects on the stock of any marine mammal from temporary loss of hearing or behavioral change (significant change in a biologically important behavior) are considered minimal. Any auditory masking in marine mammals due to low-frequency active sonar signal transmissions is not expected to be severe and would be temporary. The operation of Surveillance Towed Array Sensor System Low Frequency Active Sonar with monitoring and mitigation would result in no mortality. The likelihood of low-frequency active sonar transmissions causing marine mammals to strand is negligible (U.S. Department of the Navy 2011).

4.4.5.2.3 Maritime Traffic and Vessel Strikes

A review of the impacts of vessel strikes on marine mammals is presented in Section 3.4.4.4 (Physical Disturbance and Strike Stressors). In particular, certain large whales, such as the blue whale, are more prone to vessel strikes (Berman-Kowalewski et al. 2010; Betz et al. 2011). 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. 2004). Marine mammals such as dolphins, porpoises, and pinnipeds that can move quickly throughout the water column are not as susceptible to vessel strikes. Most vessel strikes of marine mammals reported involve commercial vessels and occur over or near the continental shelf (Laist et al. 2001). The literature review by Laist et al. (2001) concluded that vessel strikes likely have a negligible impact on the status of most whale populations, but that for small populations, vessel strikes may have considerable population-level impacts. The conservation status and abundance of the species struck would determine in large part whether the injury would have population-level impacts on that species (Laist et al. 2001; Vanderlaan and Taggart 2009).

4.4.5.2.4 Ocean Noise

As summarized by the National Academies of Science, the possibility that anthropogenic noise could harm marine mammals or significantly interfere with their normal activities is an issue of concern (National Research Council 2005). Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, and communicating with other individuals. Noise can cause behavioral disturbances, mask other sounds (including their own vocalizations), result in injury, and in some cases, even lead to death (Tyack 2009a, b; Würsig and Richardson 2008). Human-caused noises in the marine environment come from shipping, seismic and geologic exploration, military training, and other types of pulses produced by government, commercial, industry, and private sources. In addition, noise from whale-watching vessels near marine mammals has received a great deal of attention (Wartzok 2009).

Assessing whether a noise may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present near the noise, 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 the specific effects and significance of responses by marine mammals to sound exposures such as what activity the animal is engaged in at the time of the exposure (Nowacek et al. 2007; Southall et al. 2007). Potential impacts on marine mammals from ocean noise include behavioral reactions, hearing loss in the form of temporary threshold shift (TTS) or PTS, auditory masking, injury, and mortality. Section 3.4.3.1 (Acoustic Stressors) discusses these and other possible impacts of ocean noise on marine mammals.

4.4.5.2.5 Ocean Pollution

As discussed in Sections 4.3.5.5 (Ocean Pollution) and 3.4.2.4 (General Threats), pollutants from multiple sources are present in, and continue to be released into, the oceans. Elevated concentrations of certain compounds have been measured in tissue samples from marine mammals. Long-term exposure to pollutants poses potential risks to the health of marine mammals, although for the most part, the impacts are just starting to be understood (Reijnders et al. 2008). Section 3.4.2.4 (General Threats) provides an overview of these potential impacts.

If the health of an individual marine mammal were compromised by long-term exposure to pollutants, it is possible that this condition could alter the animal's expected response to stressors associated with Alternatives 1 and 2. The behavioral and physiological responses of any marine mammal to a potential stressor, such as underwater sound, could be influenced by a number of other factors, including disease, dietary stress, body burden of toxic chemicals, energetic stress, percentage body fat, age, reproductive state, size, and social position. Synergistic impacts are also possible. For example, animals exposed to some chemicals may be more susceptible to noise-induced loss of hearing sensitivity (Fechter 2005). While the response of a previously stressed animal might be different than the response of an unstressed animal, there are no data available at this time to accurately predict how stress caused by various ocean pollutants would alter a marine mammal's response to stressors associated with Alternatives 1 and 2.

4.4.5.2.6 Climate Change

The global climate is changing and having 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 or terrestrial areas) 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 reproductive success and survival. Climate change also may influence marine mammals through effects on human behavior, such as increased shipping and oil and gas extraction, resulting from sea ice loss (Simmons et al. 2010); see Section 3.4 (Marine Mammals) for more information on impacts on marine mammals.

4.4.5.2.7 Commercial Fishing

Several commercial fisheries operate in the Study Area. Potential impacts from these activities include marine mammal injury and mortality from bycatch and entanglement. Fisheries have also resulted in profound changes to the structure and function of marine ecosystems that adversely affect marine mammals.

Between 1990 and 1999, the annual mean bycatch of marine mammals in U.S. fisheries was more than 6,000 animals, and most of these were killed in gill-net fisheries (Read et al. 2006). The impacts of bycatch on marine mammal populations vary based on removal rates, population size, and reproductive rates. Small populations with relatively low reproductive rates are most susceptible. Bycatch rates for about 12 percent of U.S. marine mammal stocks (almost all cetaceans) exceed their potential biological removal levels (Read 2008). The potential biological removal level is the number of animals that can be removed each year without preventing a stock from reaching or maintaining its optimal sustainable population level.

As discussed in Section 3.4.4.5 (Entanglement Stressors), entanglement in fishing gear is another major threat to marine mammals in the Study Area. In addition, overfishing of many fish stocks has resulted in significant changes in trophic structure, species assemblages, and pathways of energy flow in marine ecosystems (Jackson et al. 2001; Myers and Worm 2003; Pauly et al. 1998). These ecological changes may have important and likely adverse consequences for populations of marine mammals (DeMaster et al. 2001).

In summary, future commercial fishing activities in the Study Area are expected to result in significant impacts on some marine mammal species based on the relatively high injury and mortality rates associated with bycatch and entanglement. This mortality could result in or contribute to population declines for some species. Ecological changes brought about by commercial fishing are also expected to adversely impact marine mammals in the Study Area.

4.4.5.3 Cumulative Impacts on Marine Mammals

The current aggregate impacts of past, present actions, and reasonably foreseeable future actions are expected to result in significant impacts on some marine mammal species in the Study Area. The impacts are considered significant because vessel strikes, bycatch, and entanglement associated with other actions are expected to result in relatively high rates of injury and mortality that could cause population declines in some species. Alternatives 1 and 2 could also result in injury and mortality to individuals of some marine mammal species from underwater explosions, sonar, and vessel strikes. Injury and mortality that might occur under Alternatives 1 and 2 would be additive to injury and mortality associated with other actions. However, the relative contribution of the Proposed Action to the overall injury and mortality would be low compared to other actions. While quantitative estimates of marine mammal mortality from other actions are not available, bycatch for cetaceans and pinnipeds in the United States accounted for 4,146 mortalities in 1999 (Read et al. 2006).

Ocean noise associated with other actions and acoustic stressors (underwater explosions and sonar) associated with Alternatives 1 and 2 could also result in additive behavioral impacts on marine mammals. Other future actions such as construction and operation of liquefied natural gas terminals, and wave and tidal energy facilities would be expected to result in MMPA Level B harassment. However, it is unlikely that these actions and underwater explosions or sonar use would overlap in time and space because these activities are dispersed and the sound sources are intermittent. Furthermore, most of these other actions are not compatible with or could interfere with training and testing activities that involve underwater explosions and sonar use. The Navy takes appropriate coordination and scheduling steps (described in Section 3.12, Socioeconomic Resources) to avoid activities that interfere with or are not compatible with training and testing.

It is likely that distant shipping noise, which is more universal and continuous, and sound associated with underwater explosions and sonar would overlap in time and space. However, there is no evidence indicating that the co-occurrence of shipping noise and sounds associated with underwater explosions and sonar use would result in harmful additive impacts on marine mammals.

The potential also exists for the impacts of ocean pollution and acoustic stressors associated with Alternatives 1 and 2 to be additive or synergistic. It is possible that the response of a previously stressed animal would be more severe than the response of an unstressed animal.

In summary, the current aggregate impacts of past and present actions and reasonably foreseeable future actions are expected to result in significant impacts on some marine mammal species in the Study Area. Therefore, cumulative impacts on marine mammals would be significant without consideration of the impacts of Alternatives 1 and 2. Alternatives 1 and 2 would contribute to and increase cumulative impacts, but the relative contribution would be low compared to other actions.

4.4.6 Sea Turtles

4.4.6.1 Impacts of Alternatives 1 and 2 That May Contribute to Cumulative Impacts

Impacts of Alternatives 1 and 2 that might contribute to cumulative impacts on sea turtles include mortality, injury, and short-term disturbance or behavioral modification. Mortality or injury could be caused by underwater explosions or vessel strikes. Injury, in the form of PTS, could also be caused by sonar use. Noninjurious impacts of underwater explosions and sonar use would include short-term disturbance or behavioral modification. The Navy's ESA determinations presented in Table 3.5-13 are "no effect" or "may affect, not likely to adversely affect" for the remaining stressors analyzed in Section 3.5 (Sea Turtles). The incremental contribution of these remaining stressors to cumulative impacts on sea turtles would be negligible. Therefore, these stressors are not considered further in the cumulative impacts analysis.

4.4.6.2 Impacts of Other Actions

The potential impacts of other actions that are relevant to the cumulative impact analysis for sea turtles include the following:

- Mortality associated with vessel strikes, bycatch in fisheries, entanglement, and stressors associated with coastal development and human use of coastal environments
- Injury associated with vessel strikes, bycatch, entanglement, and underwater sound
- Disturbance, behavioral modifications, and reduced animal fitness associated with underwater noise
- Reduced animal fitness associated with ocean pollution
- Habitat loss related to coastal development

Most of the other actions and considerations retained for analysis in Section 3.5 (Sea Turtles) include operation of marine vessels. Exceptions include the actions listed under environmental regulations and planning. Stressors associated with marine vessel operations that are of primary concern for the cumulative impacts analysis includes vessel strikes and underwater noise. Many of the actions would also result in underwater noise from sources other than vessels. Rather than discussing these stressors for individual actions, their aggregate impacts are considered below as "other environmental considerations" in maritime traffic (Section 4.4.6.3, Maritime Traffic and Vessel Strikes) and ocean noise (Section 4.4.6.4, Ocean Noise). Similarly, many of the actions could result in ocean pollution. The aggregate impacts of water pollution are addressed below in the ocean pollution section (Section 4.4.6.5, Ocean Pollution). Bycatch is associated with commercial fishing, and the primary cause of entanglement is commercial fishing. Therefore, these stressors are discussed below in the commercial fishing section (Section 4.4.6.6, Commercial Fishing).

4.4.6.2.1 Surveillance Towed Array Sensor System Low Frequency Active Sonar

Sea turtles could be affected if they are inside the mitigation zone (180 dB sound field) during a Surveillance Towed Array Sensor System Low Frequency Active Sonar transmission. However, because received levels from Surveillance Towed Array Sensor System Low Frequency Active Sonar operations would be below 180 dB sound pressure level within 12 nm or greater distance of any coastlines and offshore biologically important areas, effects on a sea turtle stock could occur only if a significant portion of the stock encountered the Surveillance Towed Array Sensor System Low Frequency Active Sonar vessel in the open ocean. The potential for Surveillance Towed Array Sensor System Low Frequency Active Sonar operations to expose sea turtle stocks to injurious (nonauditory or PTS) sound levels or to cause TTS or behavioral changes is considered negligible because (U.S. Department of the Navy 2011):

- Most sea turtle species inhabit the earth's oceanic temperate zones, where sound propagation is predominantly characterized by downward refraction (higher transmission loss, shorter

range), rather than ducting (lower transmission loss, longer range), which is usually found in cold-water regimes.
- Sea turtle distribution and density are generally low at ranges greater than 12 nm from the coast.
- The Surveillance Towed Array Sensor System Low Frequency Active Sonar signal has a narrow bandwidth (approximately 30 Hz).
- The ship is always moving, and the system has a low duty cycle (estimated 7.5 percent), which means sea turtles would have less opportunity to be in the mitigation zone during a transmission.
- Visual monitoring mitigation is incorporated into the Preferred Alternative.

4.4.6.3 Maritime Traffic and Vessel Strikes

Maritime traffic has increased over the past 50 years, and continued increases are expected in the future. Vessel strikes have been and will continue to be a cause of sea turtle mortality and injury throughout portions of the Study Area where sea turtles regularly occur. 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 are unlikely.

Some vessel strikes would cause temporary reversible impacts, such as diverting the turtle from its previous activity or causing minor injury. A National Research Council report qualitatively ranked the relative importance of various mortality factors for sea turtles. Vessel strikes were ranked 10th, behind leading factors of shrimp trawling and other fisheries (National Research Council 1990). Major strikes would cause permanent injury or death from bleeding, 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 living 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.

4.4.6.4 Ocean Noise

Potential impacts on sea turtles from ocean noise include behavioral reactions, hearing loss in the form of TTS or PTS, auditory masking, injury, and mortality. Section 3.5.3.1 (Acoustic Stressors) discusses these and other possible impacts of ocean noise on sea turtles.

4.4.6.5 Ocean Pollution

Marine debris can also be a problem for sea turtles through entanglement or ingestion. Sea turtles can mistake debris for prey; one study found 37 percent of dead leatherbacks to have ingested various types of plastic (Mrosovsky et al. 2009). Other marine debris, including abandoned fishing gear and cargo nets, can entangle and drown turtles in all life stages.

4.4.6.6 Commercial Fishing

Bycatch is one of the most serious threats to the recovery and conservation of sea turtle populations (National Research Council 1990; Wallace et al. 2010). Among fisheries that incidentally capture sea turtles, certain types of trawl, gillnet, and longline fisheries generally pose the greatest threat. One comprehensive study estimated that worldwide, 447,000 turtles are killed each year from bycatch in commercial fisheries (Wallace et al. 2010).

Other fisheries that result in sea turtle bycatch in the Study Area include pelagic fisheries for swordfish, tuna, shark, and billfish; purse seine fisheries for tuna; commercial and recreational rod and reel fisheries; gillnet fisheries for shark; driftnet fisheries; and bottom longline fisheries (National Marine Fisheries Service 2009).

4.4.6.7 Coastal Development

Coastal development and increased human populations in coastal areas will continue to have impacts on sea turtles such as nesting beach habitat degradation, beach vehicular driving, beach lighting, power plant entrainment, and degradation of nearshore water quality and seagrass beds (see Section 3.5, Sea Turtles, for more information on impacts on sea turtles).

4.4.6.8 Climate Change

Climate change will have impacts on sea turtles such as rising sea level, decreasing nesting beach habitat, increasing ocean temperatures, and acidification degrading water quality and seagrass beds (see Section 3.5, Sea Turtles, for more information on impacts on sea turtles).

4.4.6.9 Cumulative Impacts on Sea Turtles

The current aggregate impacts of past, present, and reasonably foreseeable future actions are expected to result in impacts on sea turtles. These aggregate impacts include those from bycatch, vessel strikes, entanglement, and other stressors associated with other actions which are expected to result in high rates of injury and mortality that could cause population declines to ESA-listed species or inhibit species recovery. The Preferred Alternative could also result in injury and mortality to individual sea turtles from underwater explosions, sonar, and vessel strikes. Injury and mortality that might occur under Alternatives 1 and 2 would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 and 2 to the overall injury and mortality would be low compared to other actions. No sea turtle mortalities are estimated for Alternatives 1 and 2 (see Section 3.5.3.1.7.1, Model-Predicted Impacts).

Ocean noise associated with other actions and sound associated with acoustic stressors (underwater explosions and sonar) associated with Alternatives 1 and 2 could also result in additive behavioral impacts on sea turtles. Other future actions such as construction and operation of liquefied natural gas terminals, and wave and tidal energy facilities would be expected to result in similar impacts. However, it is unlikely that these actions and underwater explosions or sonar use would overlap in time and space because all of these activities are widespread and the sources are intermittent. Furthermore, most of these other actions are not compatible with or could interfere with training and testing activities that involve underwater explosions and sonar use. The Navy takes appropriate steps to avoid activities that interfere with or are not compatible with training and testing.

It is likely that distant shipping noise (which is more pervasive and continuous) and sound associated with underwater explosions and sonar would overlap in time and space. However, there is no evidence indicating that the co-occurrence of shipping noise and sounds associated with underwater explosions and sonar use would result in harmful additive impacts on sea turtles.

The potential also exists for the impacts of ocean pollution and acoustic stressors associated with Alternatives 1 and 2 to be additive or synergistic. It is possible that the response of a previously stressed animal would be more severe than the response of an unstressed animal. However, there are no data indicating that a sea turtle affected by ocean pollution would be more susceptible to stressors associated with Alternatives 1 and 2.

In summary, the current aggregate impacts of past and present actions and reasonably foreseeable future actions are expected to result in impacts on sea turtles. Therefore, impacts on sea turtles would be significant without consideration of the impacts of Alternatives 1 and 2. Alternatives 1 and 2 would contribute to and increase cumulative impacts, but the relative contribution would be low compared to other actions.

4.4.7 Marine Birds

The analysis in Section 3.6 (Marine Birds) indicates that birds could potentially be impacted by acoustic stressors (sonar and other active acoustic sources, underwater explosions, weapons firing noise, aircraft noise, vessel noise), energy stressors (electromagnetic devices), physical disturbance and strikes (aircraft, aerial targets, vessels and in-water devices, military expended materials), and ingestion (military expended materials). Potential responses would include a startle response, which includes short-term behavioral (e.g., movement) and physiological components (e.g., increased heart rate). Recovery from the impacts of most stressor exposures would occur quickly, and impacts would be localized. Some stressors, including underwater explosions, physical strikes, and ingestion of plastic military expended materials, could result in mortality. However, the number of individual birds affected is expected to be low, and no population-level impacts are expected. The impacts of Alternatives 1 and 2 would be cumulative with other actions that cause short-term behavioral and physiological impacts and mortality to birds. However, the incremental contribution of Alternatives 1 and 2 to cumulative impacts on birds would be low for the following reasons:

- Most of the proposed activities would be widely dispersed in offshore areas, where bird distribution is patchy and concentrations of individuals are often low. Therefore, the potential for interactions between birds and training and testing activities is low.
- It is unlikely that training and testing activities would influence nesting because most activities take place in water and away from nesting habitats on land. Alternatives 1 and 2 would not result in destruction or loss of nesting habitat.
- For most stressors, impacts would be short term and localized, and recovery would occur quickly.
- While a limited amount of mortality could occur, no population-level impacts would be expected.
- The Preferred Alternative is not likely to adversely affect ESA-listed bird species.

Based on the analysis in Section 3.6 (Marine Birds), and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible. Further analysis of cumulative impacts on birds is not warranted.

4.4.8 Marine Vegetation

The analysis presented in Section 3.7 (Marine Vegetation) indicates that marine vegetation could be affected by acoustic stressors (underwater explosions) and physical stressors (interactions with vessels and in-water devices, military expended materials, or seafloor devices). Potential impacts include localized disturbance and mortality. Recovery would occur quickly, and population-level impacts are not anticipated. The impacts of Alternatives 1 and 2 would be cumulative with other actions that cause disturbance and mortality of marine vegetation.

The current aggregate impacts of past, present, and reasonably foreseeable future actions presented in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) may have a significant effect on marine vegetation. These aggregate impacts are considered significant because vessel strikes, increased sedimentation, and other stressors associated with other actions discussed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) and Table 4.3-1 are expected to result in injury and mortality that could inhibit species recovery. Although this EIS/OEIS does address some of these projects, developments and actions listed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis), many of these other actions and their associated cumulative impacts on marine vegetation cannot be determined with any specificity or certainty at this time. However, it can reasonably be assumed that there may be marine vegetation that could be affected by these actions, but with no specific details regarding the individual impacts or effects. Alternatives 1 and 2 could also result in injury and mortality to marine vegetation from underwater explosions and strikes. Injury and mortality that might occur under the Preferred Alternative would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 and 2 to the overall injury and mortality would be low compared to other actions for the following reasons:

- Most training and testing activities would occur in areas where seagrasses and other attached marine vegetation do not grow.
- Impacts would be localized, recovery would occur quickly, and no population-level impacts would be expected.
- Proposed training and testing activities would not result in impacts that have been historically significant to marine vegetation. For example Alternatives 1 and 2 would not increase nutrient loading, which can cause algal blooms, decrease light penetration, and impact photosynthesis of seagrasses.

Alternatives 1 and 2 would not result in long-term or widespread changes in environmental conditions such as turbidity, salinity, pH, or water temperature that could impact marine vegetation. Based on the analysis presented in Section 3.7 (Marine Vegetation) and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible. Further analysis of cumulative impacts on marine vegetation is not warranted.

4.4.9 Marine Invertebrates

The analysis presented in Section 3.8 (Marine Invertebrates) indicates that marine invertebrates could be affected by acoustic stressors (sonar and other active acoustic sources, underwater explosions, weapons firing noise, aircraft noise, vessel noise), energy stressors (electromagnetic devices), physical disturbance or strikes (vessels and in-water devices, military expended materials, seafloor devices), entanglement (fiber optic cables and guidance wires, decelerator/parachutes), and ingestion (military expended materials).

The current aggregate impacts of past, present, and reasonably foreseeable future actions presented in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) may have a significant effect on marine invertebrates. These aggregate impacts are considered significant because vessel strikes, dredging, and other stressors associated with other actions discussed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) and Table 4.3-1 are expected to result in injury and mortality that could cause population declines to ESA-listed species or inhibit species recovery. Although this EIS/OEIS does address some of these other actions listed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis), many of these actions and their associated cumulative impacts on marine invertebrates cannot be determined with any specificity or certainty at this time. However, it can reasonably be assumed that there may be marine invertebrates that could be affected by these actions, but with no specific details regarding the individual impacts or effects. Alternatives 1 and 2 could also result in injury and mortality to marine invertebrates from underwater explosions, entanglement, and strikes. Injury and mortality that might occur under Alternatives 1 and 2 would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 and 2 to the overall injury and mortality would be low compared to other actions for the following reasons:

- Most potential impacts would be short-term behavioral and physiological responses.
- Any impacts from the Proposed Action resulting injury or mortality would be to a relatively small number of individuals.
- No population-level impacts are anticipated.

Based on the analysis presented in Section 3.8 (Marine Invertebrates) and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible.

4.4.10 Fish

The analysis presented in Section 3.9 (Fish) indicates that fish could be affected by acoustic stressors (sonar and other active acoustic sources, explosives, swimmer defense airguns; weapons firing, launch, and impact noise; aircraft noise; and vessel noise), energy (electromagnetic devices), physical disturbance or strikes (vessels and in-water devices, military expended materials, seafloor devices), entanglement (fiber optic cables and guidance wires, decelerator/parachutes), and ingestion (munitions, military expended materials other than munitions).

The current aggregate impacts of past, present, and reasonably foreseeable future actions presented in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) may have a significant effect on fish. These aggregate impacts are considered significant because vessel strikes, entanglement, and other stressors associated with the other actions discussed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis) and Table 4.3-1 are expected to result in injury and mortality that could inhibit species recovery. Although this EIS/OEIS does address some of these other actions listed in Section 4.3 (Other Actions Analyzed in the Cumulative Impacts Analysis), many of these actions and their associated cumulative impacts on fish, cannot be determined with any specificity or certainty at this time. However, it can reasonably be assumed that there may be fish that could be affected by these other actions, but with no specific details regarding the individual impacts or effects. Alternatives 1 and 2 could also result in injury and mortality to fish from underwater explosions, entanglement, and strikes. Injury and mortality that might occur under Alternatives 1 and 2 would be additive to injury and mortality associated with other actions. However, the relative contribution of Alternatives 1 and 2 to the overall injury and mortality would be low compared to other actions for the following reasons:

- Most potential impacts would be short-term behavioral and physiological responses.
- Any impacts from the Proposed Action resulting injury or mortality would be to a relatively small number of individuals.
- No population-level impacts are anticipated.

Based on the analysis presented in Section 3.9 (Fish) and the reasons summarized above, the incremental contribution of Alternatives 1 and 2 to cumulative impacts would be negligible.

4.4.11 Terrestrial Species and Habitats

The analysis presented in Section 3.10 (Terrestrial Species and Habitats) indicates that terrestrial species could be affected by acoustic stressors (explosions, aircraft noise, and weapons firing noise), physical disturbance or strikes (aircraft, munitions strike, ground disturbance, and wildfires), and secondary stressors. Potential responses would include a startle response, which includes short-term behavioral (e.g., movement) and physiological components (e.g., increased heart rate). Recovery from the impacts of most stressor exposures would occur quickly, and impacts would be localized. Based on the type of activities in the various land training areas of the MITT Study Area, the Navy presents the following summary of effects determinations to ESA-listed species and critical habitats.

4.4.11.1 Critical Habitat

4.4.11.1.1 Critical Habitats on Guam

Critical habitat is designated on Guam for the Mariana crow, Mariana fruit bat, and Micronesian kingfisher. The critical habitat designations for these species are confined to the terrestrial portions of the Guam National Wildlife Refuge fee simple portion (Ritidian Unit). Because training does not occur within the Ritidian Unit and there is no need for training to access the portion of the road that descends down Ritidian Cliff to the Ritidian Unit, the Navy concludes that training and testing activities will not affect critical habitat designated on Guam.

4.4.11.1.2 Critical Habitats on Rota

Critical habitat is designated on Rota for the Mariana crow and Rota bridled white-eye. The Navy does not train in these areas; therefore the Proposed Action will not affect or represent an adverse modification to the designated critical habitat units on Rota and will not disturb the various primary constituent elements. The Navy concludes that the avoidance of designated critical habitat and measures designed for habitat protections described in Section 3.10.1.2 (Migratory Bird Treaty Act and 50 Code of Federal Regulations Part 21.15 Requirements) are sufficient to not affect designated critical habitat on Rota.

4.4.11.2 Summary of Endangered Species Act Effects Determinations

In 2010, the U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office issued a Biological Opinion, pursuant with Section 7 of the ESA, on proposed training and testing activities within the Mariana Islands Range Complex (MIRC), which is a portion of the MITT Study Area. The Biological Opinion concluded that training and testing activities within MIRC would have no effect on the Guam rail, short-tailed albatross, Hawaiian petrel, or Newell's shearwater. These no effect determinations were primarily based on the rare occurrence of these species within MIRC, and absence from breeding grounds and rookery sites located at Farallon de Medinilla. However, the analysis in Section 3.10 (Terrestrial Species and Habitats) notes that acoustic stressors (from explosives) and physical disturbance (from munitions strikes and wildfires) may affect, likely to adversely affect the Micronesian megapode on Farallon de Medinilla.

In summary, the current aggregate impacts of past and present actions and reasonably foreseeable future actions are not expected to result in significant impacts on terrestrial species. The only significant impacts to a terrestrial species, from training and testing activities would be on the Micronesian megapode. There are no other activities or actions, besides the training and testing activities analyzed in Section 3.10 (Terrestrial Species and Habitats) on Farallon de Medinilla that could contribute to cumulative impacts on the Micronesian megapode population.

4.4.12 Cultural Resources

4.4.12.1 Impacts of Alternatives 1 and 2 That Might Contribute to Cumulative Impacts

As discussed in Section 3.11 (Cultural Resources), Alternatives 1 and 2 could impact submerged historic resources if certain training and testing activities are conducted where these resources occur and are not avoided. Stressors that could impact cultural resources include acoustic (underwater explosions at depth), physical disturbance (cratering from underwater detonations at depth, use of in-water devices, deposition of military expended materials, and use of ocean-bottom-deployed devices). However, the Navy routinely avoids locations of known obstructions, which includes submerged historic resources, to prevent damage to sensitive Navy equipment and vessels and to ensure the accuracy of training and testing exercises.

4.4.12.2 Impacts of Other Actions

With a few exceptions, most of the other actions retained for cumulative impacts analysis (see Table 4.3-1) would involve some form of disturbance to the ocean bottom. Exceptions include seismic surveys, environmental regulations and planning actions, ocean pollution, and most forms of ocean noise. Actions that would disturb the ocean bottom could impact submerged cultural resources if those resources are not avoided. Any physical disturbance on the ocean floor could inadvertently damage or destroy submerged historic resources if avoidance and mitigation measures are not implemented.

Other actions that result in ocean bottom disturbance require some form of federal authorization or permitting. Therefore, requirements of the National Historic Preservation Act apply to actions in territorial waters. Federal agency procedures have been implemented to identify cultural resources, avoid impacts, and mitigate impacts that cannot be avoided. For example, the Bureau of Ocean Energy Management has procedures in place to identify the probability of the presence of submerged historic resources shoreward from the 148-foot (45-meter) isobath. It also has procedures for project redesign or relocation to avoid identified resources (Minerals Management Service 2007). Nonetheless, inadvertent impacts could occur if submerged cultural resources are present. However, inadvertent impacts are greatly reduced when avoidance and mitigation measures are put in place.

4.4.12.3 Cumulative Impacts on Cultural Resources

Impacts on submerged cultural resources from other actions would typically be avoided or mitigated through implementation of federal agency programs. However, impacts could occur if avoidance or mitigation measures are not implemented or if inadvertent disturbance or destruction of resources occurs. Disturbance or destruction of submerged historic sites, including shipwrecks, would diminish the overall record for these resources and decrease the potential for meaningful research on these resources. When considered with other actions, Alternatives 1 and 2 would not contribute to cumulative impacts on submerged historic resources, if such resources are present in areas where bottom disturbing training and testing activities take place.

4.4.13 Socioeconomic Resources

The analysis in Section 3.12 (Socioeconomic Resources) indicates that the impacts of Alternatives 1 and 2 on socioeconomic resources would be negligible. Alternatives 1 and 2 are not expected to contribute incrementally to cumulative socioeconomic impacts. Therefore, further analysis of cumulative impacts on socioeconomic resources is not warranted.

4.4.14 PUBLIC HEALTH AND SAFETY

The analysis presented in Section 3.13 (Public Health and Safety) indicates that the impacts of Alternatives 1 and 2 on public health and safety would be negligible. Alternatives 1 and 2 are not expected to contribute incrementally to cumulative health and safety impacts. Therefore, further analysis of cumulative impacts on public health and safety is not warranted.

4.5 SUMMARY AND CONCLUSIONS

Marine mammals, sea turtles, and terrestrial species are the primary resources of concern for cumulative impacts analysis:

- Past human activities have impacted these resources to the extent that several marine mammal species and terrestrial species, and all sea turtles species occurring in the Study Area are ESA-listed. Several marine mammal species and stocks are also classified as strategic stocks under MMPA.
- These resources would be impacted by multiple ongoing and future actions.
- Explosive detonations and vessel strikes under the No Action Alternative, Alternative 1, and Alternative 2 have the potential to disturb, injure, or kill marine mammals and sea turtles.

The aggregate impacts of past, present, and other reasonably foreseeable future actions are expected to result in significant impacts on some marine mammal, terrestrial, and all sea turtle species in the Study Area. The No Action Alternative, Alternative 1, or Alternative 2 would contribute to cumulative impacts, but the relative contribution would be low compared to other actions. Compared to potential mortality, strandings, or injury resulting from Navy training and testing activities, marine mammal and sea turtle mortality and injury from bycatch, commercial vessel ship strikes, entanglement, ocean pollution, and other human causes are estimated to be orders of magnitude greater (hundreds of thousands of animals versus tens of animals) (Culik 2004; International Council for the Exploration of the Sea 2005; Read et al. 2006).

The analysis presented in this chapter and Chapter 3 (Affected Environment and Environmental Consequences) indicates that the incremental contribution of the No Action Alternative, Alternative 1, or Alternative 2 to cumulative impacts on sediments and water quality, air quality, marine habitats, birds, marine vegetation, marine invertebrates, fish, terrestrial species and habitats, socioeconomic resources, and public health and safety would be negligible. When considered with other actions, the No Action Alternative, Alternative 1, or Alternative 2 might contribute to cumulative impacts on submerged prehistoric and historic resources, if such resources are present in areas where bottom-disturbing training and testing activities take place. The No Action Alternative, Alternative 1, or Alternative 2 would also make an incremental contribution to greenhouse gas emissions, representing approximately 0.005 percent of U.S. 2009 greenhouse gas emissions.

This Page Intentionally Left Blank

REFERENCES

Andrew, R. K., Howe, B. M. & Mercer, J. A. (2002). Ocean ambient sound: Comparing the 1960s with the 1990s for a receiver off the California coast. *Acoustics Research Letters Online, 3*(2). 10.1121/1.1461915.

Berman-Kowalewski, M., Gulland, F. M. D., Wilkin, S., Calambokidis, J., Mate, B., Cordaro, J., Dover, S. (2010). Association Between Blue Whale (<I>Balaenoptera musculus</I>) Mortality and Ship Strikes Along the California Coast. *Aquatic Mammals, 36*(1), 59-66. 10.1578/am.36.1.2010.59.

Betz, S., Bohnsack, K., Callahan, A. R., Campbell, L. E., Green, S. E. & Labrum, K. M. (2011). *Reducing the Risk of Vessel Strikes to Endangered Whales in the Santa Barbara Channel: An Economic Analysis and Risk Assessment of Potential Management Scenarios.* (A group project submitted in partial satisfaction of the requirements for the degree of Master of Environmental Science and Management). Bren School of Environmental Science & Management, University of California, Santa Barbara.

Boesch, D. F., Anderson, D. M., Horner, R. A., Shumway, S. E., Tester, P. A. & Whitledge, T. E. (1997). *Harmful algal blooms in coastal waters: Options for prevention, control, and mitigation.* (NOAA Coastal Ocean Office, Decision Analysis Series No. 10). Silver Spring, MD: NOAA Coastal Ocean Office.

Council on Environmental Quality. (1997). *Considering cumulative effects under the National Environmental Policy Act*.

Council on Environmental Quality. (2010). *Draft NEPA guidance on consideration of the effects of climate change and greenhouse gas emissions*. Prepared for heads of federal departments and agencies.

Culik, B. M. (2004). Review of small cetaceans: Distribution, behaviour, migration and threats.

DeMaster, D. P., Fowler, C. W., Perry, S. L. & Richlen, M. F. (2001). Predation and competition: The impact of fisheries on marine-mammal populations over the next one hundred years. *Journal of Mammalogy, 82*(3), 641–651.

Department of Defense. (2012). Operational Energy Strategy: Implementation Plan. (p. 28). Washington, D.C. Prepared by Assistant Secretary of Defense for Operational Energy Plans & Programs.

Environmental and Energy Study Institute. (2009). Navy Announces Goals to Reduce Energy Demand, Increase Renewable Supply. In *Educating Congress on energy efficiency and renewable energy; advancing innovative policy solutions,*. Retrieved from http://www.eesi.org/102609_navy

Fechter, L. D. (2005). Ototoxicity. *Environmental Health Perspectives, 113*(7), 443–444.

Gerstein, E. R. (2002). Manatees, bioacoustics and boats: hearing tests, environmental measurements and acoustic phenomena may together explain why boats and animals collide. *American Scientist, 90*(2), 154-163. doi: 10.1511/2002.2.154.

Hazel, J., Lawler, I. R., Marsh, H. & Robson, S. (2007). Vessel speed increases collision risk for the green turtle *Chelonia mydas*. *Endangered Species Research, 3*, 105–113.

Hildebrand, J. (2004). Sources of anthropogenic sound in the marine environment.

Intergovernmental Panel on Climate Change. (2007). Technical Summary.

International Council for the Exploration of the Sea. (2005). Report of the ad-hoc group on the impacts of sonar on cetaceans and fish (AGISC).

Jackson, J. B. C., M. X. Kirby, W. H. Berger, K. A. Bjorndal, L. W. Botsford, B. J. Bourque, R. H. Bradbury, R. Cooke, J. M. Erlandson, J. A. Estes, T. P. Hughes, S. Kidwell, C. B. Lange, H. S. Lenihan, J. M. Pandolfi, C. H. Peterson, R. S. Steneck, M. J. Tegner and R. R. Warner. (2001). Historical overfishing and the recent collapse of coastal ecosystems. *Ecology Through Time, 293*.

Karl, T. R., Melillo, J. M. & Peterson, T. C. (2009). *Global climate change impacts in the United States*. New York, NY: Cambridge University Press.

Laist, D. W., Knowlton, A. R., Mead, J., Collet, A. & Podesta, M. (2001). Collisions between ships and whales. *Marine Mammal Science, 17*(1), 35-75.

Laist, D. W. & Shaw, C. (2006). Preliminary evidence that boat speed restrictions reduce deaths of Florida manatees. *Marine Mammal Science, 22*(2), 472-479. doi:10.1111/j.1748-7692.2006.00027.x.

Law, K. L., Moret-Ferguson, S., Maximenko, N., Proskurowski, G., Peacock, E., Hafner, J. & Reddy, C. (2010). Plastic accumulation in the north Atlantic subtropical gyre. *Science, 329*.

Le Treut, H., Somerville, R., Cubasch, U., Ding, Y., Mauritzen, C., Mokssit, A., Prather, M. (2007). Historical Overview of Climate Change Science. In: S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (Eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 36). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Lutcavage, M., Plotkin, P., Witherington, B. & Lutz, P. (1997). Human impacts on sea turtle survival. In P. Lutz and J. A. Musick (Eds.), *The Biology of Sea Turtles* (Vol. 1, pp. 387–409). Boca Raton, FL: CRC Press.

Minerals Management Service. (2007). Gulf of Mexico OCS oil and gas lease sales: 2007–2012. Volume I: Chapters 1–8 and appendices. MMS 2007-018.

Mrosovsky, N., Ryan, G. D. & James, M. C. (2009). Leatherback turtles: The menace of plastic. *Marine Pollution Bulletin, 58*, 287–289.

Myers, R. A. & Worm, B. (2003). Rapid worldwide depletion of predatory fish communities. *Nature, 423*, 280–283.

National Marine Fisheries Service. (2006). Marine debris: Impacts in the Gulf of Mexico.

National Marine Fisheries Service. (2009). Endangered Species Act Section 7 consultation: Biological opinion for U.S. Navy activities in the Northeast, Virginia Capes, Cherry Point, and Jacksonville.

National Oceanic and Atmospheric Administration. (2011). NOAA Gulf spill restoration. Retrieved from http://www.gulfspillrestoration.noaa.gov/restoration/what-is-restoration-scoping/ as accessed on 2012, February 23.

National Research Council. (1990). Decline of the sea turtles: Causes and prevention. Washington, DC: National Academy Press.

National Research Council of the National Academies. (2003). Ocean Noise and Marine Mammals. In Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals (Ed.), *Ocean Noise and Marine Mammals* (p. 24): National Research Council of the National Academies.

National Research Council of the National Academies. (2005). Marine Mammal Populations and Ocean Noise Determining when Noise Causes Biologically Significant Effects. In National Research Council of the National Academies (Ed.). Washington DC: The National Academies Press.

Nowacek, D., Johnson, M. & Tyack, P. (2004). North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. *Proceedings of the Royal Society of London, 271*(B), 227-231. 10.1098/rspb.2003.2570.

Nowacek, D., Thorne, L. H., Johnston, D. & Tyack, P. (2007). Responses of cetaceans to anthropogenic noise. *Mammal Review, 37*(2), 81-115.

Paige, P. (2009). SECNAV Outlines Five 'Ambitious' Energy Goals, *U.S. Navy Today*.

Pauly, D., Christensen, V., Guenette, S., Pitcher, T. J., Sumaila, U. R., Walters, C. J., Zeller, D. (1998). Towards sustainability in world fisheries. *Nature, 418*, 689–695.

Read, A. J. (2008). The looming crisis: Interactions between marine mammals and fisheries. *Journal of Mammalogy, 89*(3), 541–548.

Read, A. J., Drinker, P. & Northridge, S. (2006). Bycatch of marine mammals in U.S. and global fisheries. *Conservation Biology, 20*(1), 163–169.

Reijnders, P. J. H., Aguilar, A. & Borrell, A. (2008). Pollution and marine mammals. In W. F. Perrin, B. Wursig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 890-898). San Diego, CA: Academic Press.

Salvadeo, C. J., D. Lluch-Belda, A. Gómez-Gallardo, J. Urbán-Ramírez and C. D. MacLeod. (2010). Climate change and a poleward shift in the distribution of the Pacific white-sided dolphin in the northeastern Pacific. *Endangered Species Research* 11: 13-19.

Simmonds, M. P. & Eliott, W.J. (2009). Climate change and cetaceans: Concerns and recent developments. *Journal of the Marine Biological Association of the United Kingdom* 89(1): 203-210.

Simmons, S. E., D. E. Crocker, J. L. Hassrick, C. E. Kuhn, P. W. Robinson, Y. Tremblay and D. P. Costa (2010). Climate-scale hydrographic features related to foraging success in a capital breeder, the northern elephant seal Mirounga angustirostris. *Endangered Species Research* 10: 233-243.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Greene, C., Tyack, P. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals, 33*(4), 122.

Tyack, P. (2009a). Acoustic playback experiments to study behavioral responses of free-ranging marine animals to anthropogenic sound. *Marine Ecology Progress Series, 395*, 13. 10.3354/meps08363.

Tyack, P. (2009b). Human-generated sound and marine mammals. *Physics Today*, 39–44.

U.S. Department of the Navy. (2010). Navy climate change roadmap.

U.S. Department of the Navy. (2011). Executive summary: Draft supplemental environmental impact statement/supplemental overseas environmental impact statement for surveillance towed array sensor system low frequency active (SURTASS LFA) sonar.

U.S. Environmental Protection Agency. (2009). Inventory of U.S. greenhouse gas emissions and sinks: 1990–2007.

U.S. Environmental Protection Agency. (2011). Nonpoint source pollution. Retrieved from http://www.epa.gov/reg3wapd/nps/index.htm as accessed on 2011, January 31.

U.S. Environmental Protection Agency. (2012). DRAFT Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010. (p. 470).

Vanderlaan, A. S. & Taggart, C. T. (2009). Efficacy of a Voluntary Area to Be Avoided to Reduce Risk of Lethal Vessel Strikes to Endangered Whales. *Conservation Biology, 23*(6), 1467-1474. 10.1111/j.1523-1739.2009.01329x.

Wallace, B. P., Lewison, R. L., McDonald, S. L., McDonald, R. K., Kot, C. Y., Kelez, S., Crowder, L. B. (2010). Global patterns of marine turtle bycatch.

Wartzok, D. (2009). Marine mammals and ocean noise. In J. H. Steele, K. K. Turekian and S. A. Thorpe (Eds.), *Encyclopedia of Ocean Sciences* (2nd ed., Vol. 3, pp. 628-634). Boston, MA: Academic Press.

Würsig, B. & Richardson, W. J. (2008). Noise, effects of. In W. F. Perrin, B. Wursig and J. G. M. Thewissen (Eds.), *Encyclopedia of Marine Mammals* (2nd ed., pp. 765-773). San Diego, CA: Academic Press.

5 Standard Operating Procedures, Mitigation, and Monitoring

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

5 STANDARD OPERATING PROCEDURES, MITIGATION, AND MONITORING

This chapter describes the United States (U.S.) Department of the Navy (Navy) standard operating procedures, mitigation measures, and marine species monitoring and reporting efforts. Standard operating procedures are essential to maintaining safety and mission success, and in many cases have the added benefit of reducing potential environmental impacts. Mitigation measures are designed to help reduce or avoid potential impacts on marine, terrestrial, and cultural resources. Marine species monitoring efforts are designed to track compliance with take authorizations, evaluate the effectiveness of mitigation measures, and improve understanding of the effects training and testing activities have on marine resources within the Mariana Islands Training and Testing (MITT) Study Area (Study Area).

5.1 STANDARD OPERATING PROCEDURES

Effective training, maintenance, research, development, testing, and evaluation (hereafter referred to collectively as the Proposed Action) require that participants utilize their sensors and weapon systems to their optimum capabilities as required by the activity objectives. The Navy currently employs standard practices to provide for the safety of personnel and equipment, including vessels and aircraft, as well as the success of the training and testing activities. For the purpose of this document, the Navy will refer to standard practices as standard operating procedures. Because of their importance for maintaining safety and mission success, standard operating procedures have been considered as part of the Proposed Action under each alternative, and therefore are included in the Chapter 3 (Affected Environment and Environmental Consequences) environmental analyses for each resource.

Navy standard operating procedures have been developed and refined over years of experience, and are broadcast via numerous naval instructions and manuals, including the following sources:

- Ship, Submarine and Aircraft Safety Manuals
- Ship, Submarine and Aircraft Standard Operating Manuals
- Fleet Area Control and Surveillance Facility Range Operating Instructions
- Fleet Exercise Publications and Instructions
- Naval Sea Systems Command Test Range Safety and Standard Operating Instructions
- Navy Instrumented Range Operating Procedures
- Naval Shipyard Sea Trial Agendas
- Research, Development, Test and Evaluation Plans
- Naval Gunfire Safety Instructions
- Navy Planned Maintenance System Instructions and Requirements
- Federal Aviation Administration Regulations

In many cases there are incidental environmental, socioeconomic, and cultural benefits resulting from standard operating procedures. Standard operating procedures serve the primary purpose of providing for safety and mission success, and are implemented regardless of their secondary benefits. This is what distinguishes standard operating procedures, which are a component of the Proposed Action, from mitigation measures, which are designed entirely for the purpose of reducing environmental impacts resulting from the Proposed Action. Because standard operating procedures are crucial to safety and mission success, the Navy will not modify them as a way to further reduce impacts on environmental resources. Rather, mitigation measures will be used as the tool for avoiding and reducing potential environmental impacts. Standard operating procedures that are recognized as providing a potential secondary benefit are provided below.

5.1.1 Vessel Safety

For the purposes of this chapter, the term ‘ship’ is inclusive of surface ships and surfaced submarines. The term ‘vessel’ is inclusive of ships and small boats (e.g., rigid-hull inflatable boats).

Ships operated by or for the Navy, have personnel assigned to stand watch at all times, day and night, when moving through the water (underway). Watch personnel undertake extensive training in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent, including on-the-job instruction and a formal Personal Qualification Standard Program (or equivalent program for supporting contractors or civilians), to certify that they have demonstrated all necessary skills (such as detection and reporting of floating or partially submerged objects). Watch personnel are composed of officers and enlisted men and women, and civilian equivalents. Their duties may be performed in conjunction with other job responsibilities, such as navigating the ship or supervising other personnel. While on watch, personnel employ visual search techniques, including the use of binoculars, using a scanning method in accordance with the United States Navy Lookout Training Handbook. After sunset and prior to sunrise, watch personnel employ night visual search techniques, which include the use of night vision devices.

A primary duty of watch personnel is to detect and report all objects and disturbances sighted in the water that may be indicative of a threat to the ship and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per safety requirements, watch personnel also report any marine mammals sighted that have the potential to be in the direct path of the ship, as a standard collision avoidance procedure. Because watch personnel are primarily posted for safety of navigation, range clearance, and man-overboard precautions, they are not normally posted while ships are moored to a pier. When anchored or moored to a buoy, a watch team is still maintained but with fewer personnel than when underway. When moored or at anchor, watch personnel may maintain security and safety of the ship by scanning the water for any indications of a threat (as described above).

While underway, Navy ships (with the exception of submarines) greater than 65 feet (ft.) (20 meters [m]) in length have at least two watch personnel; Navy ships less than 65 ft. (20 m) in length, surfaced submarines, and contractor ships, have at least one watch person. While underway, watch personnel are alert at all times and have access to binoculars. Due to limited manning and space limitations, small boats do not have dedicated watch personnel, and the boat crew is responsible for maintaining the safety of the boat and surrounding environment.

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.

5.1.2 Aircraft Safety

Pilots of Navy aircraft make every attempt to avoid large flocks of birds in order to reduce the safety risk involved with a potential bird strike.

5.1.3 Laser Procedures

The following procedures are applicable to lasers of sufficient intensity to cause human eye damage.

5.1.3.1 Laser Operators

Only properly trained and authorized personnel operate lasers.

5.1.3.2 Laser Activity Clearance

Prior to commencing activities involving lasers, the operator ensures that the area is clear of unprotected or unauthorized personnel in the laser impact area by performing a personnel inspection or a flyover. The operator also ensures that any personnel within the area are aware of laser activities and are properly protected.

5.1.4 WEAPONS FIRING PROCEDURES

5.1.4.1 Notice to Mariners

A Notice to Mariners is routinely issued in advance of missile firing activities. A notice is also issued in advance of explosive bombing activities when they are conducted in an area that does not already have a standing Notice to Mariners. For activities involving large caliber gunnery, the Navy evaluates the need to publish a Notice to Mariners based on the scale, location, and timing of the activity. More information on the Notices to Mariners is found in Section 3.13 (Public Health and Safety).

5.1.4.2 Weapons Firing Range Clearance

The weapons firing hazard range must be clear of non-participating vessels and aircraft before firing activities will commence. The size of the firing hazard range is based on the farthest firing range capability of the weapon being used. All missile and rocket firing activities are carefully planned in advance and conducted under strict procedures that place the ultimate responsibility for range safety on the Officer Conducting the Exercise or civilian equivalent. All weapons firing is secured when cease fire orders are received from the Range Safety Officer or when the line of fire is endangering any object other than the designated target.

Pilots of Navy aircraft are not authorized to expend ordnance, fire missiles, or drop other airborne devices through extensive cloud cover where visual clearance of the air and surface area is not possible. The two exceptions to this requirement are: (1) when operating in the open ocean, air and surface clearance through visual means or radar surveillance is acceptable; and (2) when the operational commander conducting the exercise accepts responsibility for the safeguarding of airborne and surface traffic.

During activities that involve recoverable targets (e.g., aerial drones) the Navy recovers the target and any associated decelerator/parachutes to the maximum extent practicable consistent with operational requirements and personnel safety.

5.1.4.3 Target Deployment Safety

Firing exercises involving the integrated maritime portable acoustic scoring system are typically conducted in daylight hours in Beaufort number 4 conditions or better to ensure safe operating conditions during buoy deployment and recovery. The Beaufort sea state scale is a standardized measurement of the weather conditions, based primarily on wind speed. The scale is divided into levels from 0 to 12, with 12 indicating the most severe weather conditions (e.g., hurricane force winds). At Beaufort number 4, wave heights typically range from 3.5 to 5 ft. (1.1 to 1.5 m).

5.1.5 Swimmer Defense Testing Procedures

5.1.5.1 Notice to Mariners

A Notice to Mariners is issued in advance of all swimmer defense testing.

5.1.5.2 Swimmer Defense Testing Clearance

A daily in situ calibration of the source levels is used to establish a clearance area to the 145 decibels (dB) referenced to (re) 1 micropascal (µPa) sound pressure level threshold for non-participant personnel safety. A hydrophone is stationed during the calibration sequences in order to confirm the clearance area. Small boats patrol the 145 dB re 1 µPa sound pressure level area during all test activities. Boat crews are equipped with binoculars and remain vigilant for non-participant divers and boats, swimmers, snorkelers, and dive flags. If a non-participating swimmer, snorkeler, or diver is observed entering into the area of the swimmer defense system, the power levels of the defense system are reduced. An additional 100-yard (yd.) (91.4 m) buffer is applied to the initial sighting location of the non-participant as an additional precaution. If the area cannot be maintained free of non-participating swimmers, snorkelers, and divers, testing will cease until the non-participant has moved outside the area.

5.1.6 Unmanned Aerial and Underwater Vehicle Procedures

For activities involving unmanned aerial and underwater vehicles, the Navy evaluates the need to publish a Notice to Airmen or Mariners based on the scale, location, and timing of the activity. Unmanned Aerial Vehicles and Unmanned Aircraft Systems are operated in accordance with Federal Aviation Administration air traffic organization policy as issued in Office of the Chief of Naval Operations Instructions 3710, 3750, and 4790.

5.1.7 Towed In-Water Device Procedures

Prior to deploying a towed device from a manned platform, there is a standard operating procedure to search the intended path of the device for any floating debris (e.g., driftwood) or other potential obstructions (e.g., concentrations of animals), which have the potential to cause damage to the device.

5.2 Introduction to Mitigation

The Navy recognizes that the Proposed Action has the potential to impact the environment. Unlike standard operating procedures, which are established for reasons other than environmental benefit, mitigation measures are modifications to the Proposed Action that are implemented for the sole purpose of reducing a specific potential environmental impact on a particular resource. The procedures discussed in this chapter, most of which are currently or were previously implemented as a result of past environmental compliance documents, Endangered Species Act (ESA) Biological Opinions, Marine Mammal Protection Act (MMPA) Letters of Authorization, or other formal or informal consultations with regulatory agencies, are being coordinated with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) through the consultation and permitting processes.

In order to make the findings necessary to issue an MMPA letter of authorization, it may be necessary for NMFS to require additional mitigation measures or monitoring beyond those contained in this Draft Environmental Impact Statement (EIS)/Overseas EIS (OEIS). These could include measures considered, but eliminated in this EIS/OEIS, or as yet undeveloped measures. The public will have an opportunity to provide information to NMFS through the MMPA process, both during the comment period following NMFS' notice of receipt of the application for a letter of authorization, and during the comment period following publication of the proposed rule. NMFS may propose additional mitigation measures or monitoring in the proposed rule.

Additionally, the Navy is engaging in consultation processes with both NMFS and the USFWS under the ESA with regard to listed species that may be affected by the Proposed Action described in this EIS/OEIS. For the purposes of the ESA section 7 consultation, the mitigation measures proposed here may be considered by NMFS or USFWS as beneficial actions taken by the Federal agency or applicant (50 Code of Federal Regulations [C.F.R.] 402.14[g][8]). If required to satisfy requirements of the ESA, NMFS or USFWS may develop an additional set of measures contained in reasonable and prudent alternatives, reasonable and prudent measures, or conservation recommendations in any Biological Opinion issued for this Proposed Action.

The Navy also will consider public comments on proposed mitigation measures described in this Draft EIS/OEIS.

5.2.1 Regulatory Requirements for Mitigation

An EIS must analyze the affected environment, discuss the environmental impacts of the Proposed Action and each alternative, and assess the significance of the impacts on the environment. Mitigation measures help reduce the severity or intensity of impacts of the Proposed Action, and their assessment can occur early in the planning process. An agency may choose not to take the action or to move the location of the action. Mitigation measure development also occurs throughout the analysis process whenever an impact is minimized by limiting the degree or magnitude of the action or its implementation. Mitigation measures can also include actions that repair, rehabilitate, or restore the affected environment or reduce impacts over time through constant monitoring and corrective adjustments.

In accordance with the National Environmental Policy Act (NEPA) requirement, the environmental benefit of all proposed Navy recommended mitigation measures will apply to all alternatives analyzed in this Draft EIS, and, according to Navy policy, will also apply to the Draft OEIS where applicable and appropriate. Additionally, the White House Council on Environmental Quality issued guidance for mitigation and monitoring on 14 January 2011. This guidance affirms that federal agencies, including the Navy, should:

- commit to mitigation in decision documents when they have based environmental analysis upon such mitigation (by including appropriate conditions on grants, permits, or other agency approvals, and making funding or approvals for implementing the Proposed Action contingent on implementation of the mitigation commitments);
- monitor the implementation and effectiveness of mitigation commitments;
- make information on mitigation and monitoring available to the public, preferably through agency web sites; and
- remedy ineffective mitigation when the federal action is not yet complete.

The Council on Environmental Quality guidance encourages federal agencies to develop internal processes for post-decision monitoring to ensure the implementation and effectiveness of the mitigation. It also states that federal agencies may use adaptive management as part of an agency’s action. Adaptive management, when included in the NEPA analysis, allows for the agency to take alternate mitigation actions if mitigation commitments originally made in the planning and decision documents fail to achieve projected environmental outcomes. Adaptive management generally involves four phases: plan, act, monitor, and evaluate. This process allows the use of the results to update knowledge and adjust future management actions accordingly. Through implementing mitigation measures from the Navy's previous planning, consultations, permits, and monitoring of those efforts, the Navy has collected data to further refine its recommended mitigation measures.

Through the planning, consultation, and permitting processes, federal regulatory agencies may also suggest that the Navy analyze additional mitigation measures for inclusion in the Final EIS/OEIS and associated consultation and permitting documents. Any proposals for additional mitigation measures should be based on the federal agency's assessment of the likelihood that such measures will contribute to a notable reduction of the environmental impact. If additional measures are identified, the Navy will apply the effectiveness and operational assessment protocols discussed in Section 5.3 (Mitigation Assessment) to determine whether the additional measure will be proposed for implementation. The final suite of mitigations resulting from the ongoing planning, consultation, and permitting processes will be documented in the Navy and NMFS Records of Decision, the MMPA Letters of Authorization, and the ESA Biological Opinions.

5.2.2 Overview of Mitigation Approach

This section describes the approach that the Navy took to develop its recommended mitigation measures. The Navy's overall approach to assessing potential mitigation measures was based on two principles: (1) mitigations will be effective at reducing potential impacts to the resource; and (2) from a military perspective, the mitigations are practical to implement, and personnel safety and readiness will not be impacted. The assessment process involved using information directly from Chapter 3 (Affected Environment and Environmental Consequences) and assessing all existing mitigation and proposals for new or modified mitigation in order to determine if recommending a mitigation measure for implementation would be appropriate.

This document organized, and where appropriate, analyzed training and testing activities separately. This separation was needed because the training and testing communities perform activities for differing purposes, and in some cases, with different personnel and in different locations. For example there is a fundamental difference between testing of a new mine warfare system with civilian scientists and engineers, and the eventual training of sailors and aviators with that same system. As such, mitigations that the Navy recommends for both training and testing activities are presented together, while mitigations that are designed for and executable only by the training or testing community will be presented separately.

5.2.2.1 Lessons Learned from Previous Environmental Impact Statements/Overseas Environmental Impact Statements

In an effort to improve upon past processes, the Navy considered all mitigations previously implemented and adapted its mitigation assessment approach based on lessons learned from previous EISs, ESA Biological Opinions, MMPA Letters of Authorizations, and other formal or informal consultations with regulatory agencies.

Navy planners, scientists, and the operational community assessed the effectiveness of a full suite of potential mitigation measures (a portion of which were specific mitigation areas) on a case-by-case basis, using information and lessons learned from the Navy's internal adaptive management process. The resulting assemblage of recommended measures is comprised of currently implemented measures, modifications of currently implemented measures, and newly proposed measures. Details on the assessment methods are provided in Section 5.2.3 (Assessment Method). The rationale for recommending, modifying, adding, or discontinuing each measure is provided in Section 5.3 (Mitigation Assessment).

5.2.2.2 Protective Measures Assessment Protocol

The Protective Measures Assessment Protocol is a decision support and situational awareness software tool that the Navy uses to facilitate compliance with mitigation measures when conducting certain training and testing activities at sea. The Navy runs the Protective Measures Assessment Protocol program during the event planning process to ensure that personnel involved in the activity are aware of the mitigation requirements and to help ensure that all mitigations are implemented appropriately. In addition to providing notification of the required mitigation, the tool also provides a visual display of the activity location, unit's position in relation to the target area, and any relevant environmental data. The final suite of mitigation measures contained in the Navy and NMFS Records of Decision, the MMPA Letters of Authorization, and the ESA Biological Opinions will be integrated into the Protective Measures Assessment Protocol.

Section 5.3.1.1.1.1 (United States Navy Afloat Environmental Compliance Training Series) contains information about the newly developed Protective Measures Assessment Protocol training module.

5.2.3 ASSESSMENT METHOD

As shown in Figure 5.2-1, the Navy undertook an effectiveness assessment and operational assessment for each potential mitigation measure to ensure its compatibility with Section 5.2.2 (Overview of Mitigation Approach). The Navy used information from published and readily available sources, as well as Navy after-action and monitoring reports. When available, these data were used when they represented the best available science and if they were generally accepted by the scientific community to ensure that they were applicable and contributed to the analysis.

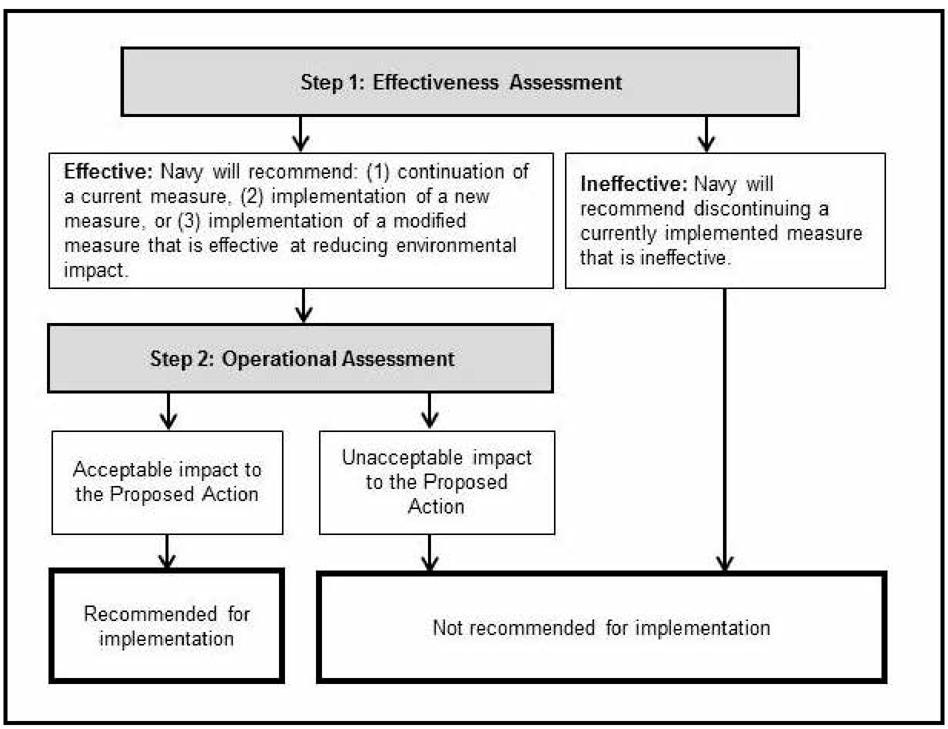


Figure 5.2-1: Flowchart of Process for Determining Recommended Mitigation Measures

5.2.3.1 Effectiveness Assessment

5.2.3.1.1 Procedural Measures

Procedural measures could involve employing techniques or technology during a training or testing activity in order to avoid or reduce a potential impact on a particular resource. For the purposes of organization, procedural measures are discussed within two subcategories: Lookouts and mitigation zones.

A proposed procedural measure was deemed effective if implementing the measure was likely to result in avoidance or reduction of an impact on a resource. The level of avoidance or reduction of the impact gained from implementing a procedural measure was weighed against the potential for a shift in impacts resulting from the activity modification. For example, if predictive modeling results indicate that the use of underwater explosives could cause unacceptable impacts on a particular resource; those impacts could possibly be reduced by substituting non-explosive activities for explosive activities. However, if the increased use of non-explosive activities would consequently produce an unacceptable impact on habitats due to an associated physical disturbance or strike risk from military expended materials, the measure would not necessarily be justifiable.

A proposed procedural measure was deemed ineffective if its implementation would not result in avoidance or reduction of an impact on a resource, or if an unacceptable impact will simply be shifted from one resource to another. For ineffective procedural measures that are currently being implemented, the rationale for terminating, modifying, or continuing to carry out the measure is included in the discussion.

5.2.3.1.2 Mitigation Areas

In order to avoid or reduce a potential impact on a particular resource the Navy would either limit the time of day or duration in which a particular activity could take place, or move or relocate a particular activity outside of a specific geographic area. Within mitigation areas, the measures would only apply to the specific activity that resulted in the requirement for mitigation, and would not prevent or restrict other activities from occurring during that time or in that area.

A proposed mitigation area was deemed effective if implementing the measure would likely result in avoidance or reduction of the impact on the resource. The specific season, time of day, or geographic area must be important to the resource. In determining importance, special consideration was given to time periods or geographic areas having characteristics such as especially high overall density or percent population use, seasonal bottlenecks for a migration corridor, and identifiable key foraging and reproduction areas.

Avoidance or reduction of the impact in the specific time period or geographic area was weighed against the potential for causing new impacts in alternative time periods or geographic areas. For example, if the use of underwater explosives was predicted to cause unacceptable impacts on a particular resource in a known foraging location, those impacts could possibly be reduced by relocating those activities to a new location. However, if the use of explosives at the new location would consequently produce an unacceptable impact on the same or a different resource at the new location, the measure would not necessarily be justifiable.

A proposed mitigation area was deemed ineffective if implementing the measure would not result in avoidance or reduction of an impact on a resource, or if an unacceptable impact would simply be shifted from one time period or location to another. For ineffective mitigation areas that are currently being implemented, the rationale for terminating, modifying, or continuing to carry out the measure is included in the discussion.

5.2.3.2 Operational Assessment

The Navy conducted the operational assessment for procedural measures and proposed mitigation areas using the criteria described below. The Navy deemed procedural and mitigation area measures to have acceptable operational impacts on a particular proposed activity if the following four conclusions were reached:

1. Implementation of the measure will not increase safety risks to Navy personnel and equipment.

2. Implementation of the measure is practicable. Practicability was defined by the following factors:

    - The measure does not result in an unacceptable increase in resource requirements (e.g., wear and tear on equipment, additional fuel, additional personnel, increased training or testing requirement, or additional reporting requirements).
    - The measure does not result in an unacceptable increase in time away from homeport for Navy personnel.
    - The measure does not result in national security concerns. Should national security require conducting more than the designated number of activities, or a change in how the Navy conducts those activities, the Navy reserves the right to provide the regulatory federal agency with prior notification and include the information in any associated exercise or monitoring reports.
    - The measure is consistent with Navy policy. Navy policy requires that mitigation measures are developed through consultation with regulatory agencies (e.g., the MMPA and ESA processes), would likely result in avoidance or reduction of an impact on a resource as determined by the effectiveness assessment, and would not negatively impact training and testing fidelity. This policy applies to the full suite of potential mitigation measures that the Navy assessed, including measures that were considered but eliminated, and, as appropriate, to currently implemented measures that the Navy is no longer recommending to implement.

3. Implementation of the measure will not result in an unacceptable impact on the effectiveness of the military readiness activity. A primary factor that will be considered for all mitigation measures is that the measure must not modify the activity in a way that no longer allows the activity to meet the intended objectives, and ultimately must not interfere with the Navy meeting all of its military readiness requirements. Specifically, for proposed mitigation area measures, the following additional factors were considered:

    - The activity is not dependent on a specific range or range support structure within the proposed mitigation area and there are alternate areas with the necessary environmental conditions (e.g., oceanographic conditions).
    - The proposed mitigation area does not hold any current or foreseeable future readiness value. This assessment will be revisited if Navy operations or national security interests conclude that training or testing needs to occur within the proposed mitigation area.
    - Implementation of the measure will not prohibit conducting shipboard maintenance, repair, and testing pierside prior to at-sea operations.

4. The Navy has legal authority to implement the measure.

If all four of the conditions above can be achieved, then the Navy will recommend the mitigation measure for implementation.

5.3 Mitigation Assessment

The effectiveness and operational assessments resulted in potential mitigation measures being organized into the following four sections:

- Section 5.3.1 (Lookout Procedural Measures) includes recommended measures specific to the use of Lookouts or trained marine species observers.
- Section 5.3.2 (Mitigation Zone Procedural Measures) includes recommended measures specific to visual observations with a mitigation zone.
- Section 5.3.3 (Mitigation Areas) includes recommended measures specific to particular locations.
- Section 5.3.4 (Mitigation Measures Considered but Eliminated) includes measures that the Navy does not recommend for implementation due to the measure being ineffective at reducing environmental impacts, having an unacceptable operational impact, or being incompatible with Section 5.2.2, (Overview of Mitigation Approach).

A summary of the Navy recommended measures is provided in Table 5.4-1.

5.3.1 Lookout Procedural Measures

As described in Section 5.1 (Standard Operating Procedures) ships have personnel assigned to stand watch at all times while underway. Watch personnel may perform watch duties in conjunction with job responsibilities that extend beyond looking at the water or air (such as supervision of other personnel). This section will introduce Lookouts who perform similar duties to watch personnel and whose duties satisfy safety of navigation and mitigation requirements.

The Navy will have two types of Lookouts for the purposes of conducting visual observations: (1) those positioned on ships, and (2) those positioned in aircraft or on small boats. Lookouts positioned on ships will be dedicated solely to diligent observation of the air and surface of the water. They will have multiple observation objectives, which include but are not limited to detecting the presence of biological resources and recreational or fishing boats, observing the mitigation zones described in Section 5.3.2 (Mitigation Zone Procedural Measures), and monitoring for vessel and personnel safety concerns.

Due to aircraft and small boat manning and space restrictions, Lookouts positioned in aircraft or on small boats may include the aircraft crew, pilot, or boat crew. Lookouts positioned in aircraft and small boats may be responsible for tasks in addition to observing the air or surface of the water (e.g., navigation of a helicopter or small boat). However, aircraft and small boat Lookouts will, considering personnel safety, practicality of implementation, and impact on the effectiveness of the activity, comply with the observation objectives described above for Lookouts positioned on surface ships.

The procedural measures described below primarily consist of having Lookouts during specific training and testing activities.

5.3.1.1 Specialized Training

5.3.1.1.1 Training for Navy Personnel and Civilian Equivalents

5.3.1.1.1.1 United States Navy Afloat Environmental Compliance Training Series

The Navy is proposing to continue implementing the Marine Species Awareness Training for watch personnel and Lookouts, and to add the requirement for additional Navy personnel and civilian equivalents to complete one or more environmental training modules.

The Navy has developed the U.S. Navy Afloat Environmental Compliance Training Series to help ensure Navy-wide compliance with environmental requirements, and to help Navy personnel gain a better understanding of their personal roles and responsibilities. The training series contains four interactive multimedia training modules. Personnel will be required to complete all modules identified in their career path training plan.

The first module is the Introduction to the U.S. Navy Afloat Environmental Compliance Training Series. The introduction module provides information on environmental laws (e.g., ESA and MMPA) and responsibilities relevant to Navy training and testing activities. The material is put into context of why environmental compliance is important to the Navy, from the most junior sailor to Commanding Officers. All personnel completing the U.S. Navy Marine Species Awareness Training will also be required to take this module.

The second module is the U.S. Navy Marine Species Awareness Training. Consistent with current requirements, all bridge watch personnel, Commanding Officers, Executive Officers, maritime patrol aircraft aircrews, anti-submarine warfare helicopter crews, civilian equivalents, and Lookouts will successfully complete the Marine Species Awareness Training prior to standing watch or serving as a Lookout. The module contained within the U.S. Navy Environmental Compliance Training Series is an update to the current Marine Species Awareness Training version 3.1. The updated training is designed to improve the effectiveness of visual observations for marine resources, including marine mammals and sea turtles. The Marine Species Awareness Training provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures.

The third module is the U.S. Navy Protective Measures Assessment Protocol. The Protective Measures Assessment Protocol is a decision support and situational awareness software tool that the Navy uses to facilitate compliance with worldwide mitigation measures during the conduct of training and testing activities at sea. The module provides instruction for generating and reviewing Protective Measures Assessment Protocol reports. Section 5.2.2.2 (Protective Measures Assessment Protocol) contains additional information on the benefits of the software tool.

The fourth module is the U.S. Navy Sonar Positional Reporting System and marine mammal incident reporting. The Navy developed the Sonar Positional Reporting System as its official record of underwater sound sources (e.g. active sonar) used under its MMPA permits. Marine mammal incidents include vessel strikes and animal strandings. The module provides instruction on the reporting requirements and procedures for both the Sonar Positional Reporting System and marine mammal incident reporting.

<u>**Effectiveness and Operational Assessment**</u>

Navy personnel undergo extensive training in order to stand watch on the bridge. Standard training includes on-the-job instruction under the supervision of experienced personnel, followed by completion of the Personal Qualification Standard program. The Personal Qualification Standard program certifies that personnel have demonstrated the skills needed to stand watch, such as detecting and reporting floating or partially submerged objects.

The U.S. Navy Afloat Environmental Compliance Training Series, including the updated Marine Species Awareness Training, is a specialized multimedia training program designed to help Navy operational and test communities best avoid potentially harmful interactions with marine species. The program provides training on how to sight marine species, focusing on marine mammals. The training also includes instruction for visually identifying sea turtles, jellyfish aggregations, and flocks of seabirds, which are often indicators of marine mammal or sea turtle presence (aggregation of sargassum or floating vegetation are also indicators; however, they are not present in the MITT Study Area). The Marine Species Awareness Training also addresses the role that watch personnel and Lookouts play in helping the Navy maintain compliance with environmental protection requirements, as well as supporting Navy environmental stewardship commitments.

In summary, the Navy believes that the U.S. Navy Afloat Environmental Compliance Training Series, including the updated Marine Species Awareness Training, is the best and most appropriate forum for teaching watch personnel and Lookouts about their responsibilities for helping reduce impacts on the marine environment. The Marine Species Awareness Training provides the Navy with invaluable training for a relatively large number of personnel. Constantly shifting personnel assignments presents a real challenge; however, the format and structure of the U.S. Navy Afloat Environmental Compliance Training Series will help the Navy reduce costs during fiscally constrained periods and provide constant access to training. Overall, the Marine Species Awareness Training is an effective tool for improving the potential for Lookouts to detect marine species while on duty.

Implementation of the Marine Species Awareness Training has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.1.2 Lookouts

The Navy proposes to use one or more Lookouts during the training and testing activities described below, which are organized by stressor category. A comparison of the currently implemented mitigation measures and recommended mitigation measures are provided where applicable. The effectiveness and operational assessments are discussed for all Lookout measures collectively in Section 5.3.1.2.5 (Effectiveness Assessment for Lookouts) and Section 5.3.1.2.6 (Operational Assessment for Lookouts). A number of training and testing activities involve the participation of multiple vessels and aircraft, which could ultimately increase the cumulative number of personnel standing watch per standard operating procedures or Lookouts posted in the vicinity of the activity (e.g., sinking exercises). The following sections discuss the minimum number of Lookouts that the Navy will use during each activity.

5.3.1.2.1 Acoustic Stressors – Non-Impulse Sound

5.3.1.2.1.1 Low-Frequency and Hull Mounted Mid-Frequency Active Sonar

Mitigation measures do not currently exist for low-frequency active sonar sources analyzed in this Draft EIS/OEIS associated with new platforms or systems, such as the Littoral Combat Ship. The Navy is proposing to (1) add mitigation measures for low-frequency active sonar and new platforms and systems, and (2) maintain the number of Lookouts currently implemented for ships using hull-mounted mid-frequency active sonar. The recommended measures are provided below.

Ships using low-frequency or hull-mounted mid-frequency active sonar sources associated with anti-submarine warfare and mine warfare activities at sea (with the exception of ships less than 65 ft. [20 m] in length, and ships that are minimally manned) will have two Lookouts at the forward position. For the purposes of this document, low-frequency active sonar does not include Surveillance Towed Array Sensor System Low-Frequency Active Sonar.

While using low-frequency or hull-mounted mid-frequency active sonar sources associated with anti-submarine warfare and mine warfare activities at sea, ships less than 65 ft. (20 m) in length, and ships that are minimally manned will have one Lookout at the forward position of the vessel due to space and manning restrictions.

Ships conducting active sonar activities while moored or at anchor (including pierside) will maintain one Lookout.

5.3.1.2.1.2 High-Frequency and Non-Hull Mounted Mid-frequency Active Sonar

Mitigation measures do not currently exist for high-frequency active sonar activities associated with anti-submarine warfare and mine warfare, or for new platforms, such as the Littoral Combat Ship; therefore, the Navy is proposing to add a new measure for these activities or platforms. The Navy is proposing to continue using the number of Lookouts currently implemented for ships or aircraft conducting non-hull mounted mid-frequency active sonar, such as helicopter dipping sonar systems. The recommended measure is provided below.

The Navy will have one Lookout on ships or aircraft conducting high-frequency or non-hull mounted mid-frequency active sonar activities associated with anti-submarine warfare and mine warfare activities at sea.

5.3.1.2.2 Acoustic Stressors – Explosives and Impulse Sound

5.3.1.2.2.1 Improved Extended Echo Ranging Sonobuoys

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have one Lookout in aircraft conducting improved extended echo ranging sonobuoy activities.

5.3.1.2.2.2 Explosive Sonobuoys Using 0.6–2.5 Pound Net Explosive Weight

Lookout measures do not currently exist for explosive sonobuoy activities using 0.6–2.5 pound (lb.) net explosive weight. The Navy is proposing to add this measure. Aircraft conducting explosive sonobuoy activities using 0.6–2.5 lb. net explosive weight will have one Lookout.

5.3.1.2.2.3 Anti-Swimmer Grenades

Lookout measures do not currently exist for activities using anti-swimmer grenades. The Navy is proposing to add this measure. The Navy will have one Lookout on the vessel conducting anti-swimmer grenade activities.

5.3.1.2.2.4 Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices

As background mine countermeasure and neutralization activities can be divided into two main categories: (1) general activities that can be conducted from a variety of platforms and locations, and (2) activities involving the use of diver-placed charges that typically occur close to shore. When either of these activities are conducted using a positive control firing device, the detonation is controlled by the personnel conducting the activity and is not authorized until the area is clear at the time of detonation.

Lookout measures do not currently exist for general mine countermeasure and neutralization activities (those not involving diver-placed charges) using positive control firing devices. The Navy is proposing to add this measure. During general mine countermeasure and neutralization activities using up to a 20 lb. net explosive weight detonation (bin E6 and below), vessels greater than 200 ft. (61 m) will have two Lookouts, while vessels less than 200 ft. (61 m) or aircraft will have one Lookout.

The Navy is proposing to clarify the number of Lookouts implemented for mine neutralization activities involving positive control diver-placed charges using up to a 20 lb. net explosive weight detonation. A charge with a 20 lb. net explosive weight is the maximum net explosive weight proposed for activities involving diver-placed charges in the Study Area. The recommended measures are below.

- During activities involving diver-placed charges under positive control, activities using up to a 20 lb. net explosive weight (bin E6) detonation will have a total of two Lookouts (one Lookout positioned on two small boats, or one small boat in combination with a helicopter).
- All divers placing the charges on mines will support the Lookouts while performing their regular duties. The Lookouts, divers, and any other personnel who may spot marine mammals and sea turtles will report all marine mammal and sea turtle sightings to their dive support vessel or range safety officer.

5.3.1.2.2.5 Mine Neutralization Activities Using Diver-Placed Time-Delay Firing Devices

As background, when mine neutralization activities using diver placed charges (up to a 20 lb. net explosive weight) are conducted with a time-delay firing device, the detonation is fused with a specified time delay by the personnel conducting the activity and is not authorized until the area is clear at the time the fuse is initiated. During these activities, the detonation cannot be terminated once the fuse is initiated due to human safety concerns.

The Navy is proposing to modify the number of Lookouts currently used for mine neutralization activities using diver-placed time-delay firing devices. As a reference, the current mitigation involves the use of six Lookouts and three small boats (two Lookouts positioned in each of the three boats) for mitigation zones equal to or larger than 1,400 yd. (1,280 m), or four Lookouts and two boats for mitigation zones smaller than 1,400 yd. (1,280 m). The Navy is proposing to modify the number of Lookouts currently used for mine neutralization activities using diver-placed time-delay firing devices because the measure is impractical to implement and is currently resulting in an unacceptable impact on military readiness. The Navy does not have the resources to maintain six Lookouts and three small boats during mine neutralization activities using diver-placed time-delay firing devices. Due to a lack of personnel and small boats available for this activity, the requirement for six Lookouts and three small boats would require reassigning personnel from other assigned duties or training activities, thus impacting the ability of the reassigned personnel to complete his or her assigned duties or other training requirements. Therefore, the Navy is currently unable to conduct the activities that require six Lookouts and three small boats, which is reducing the Navy's ability to maintain military readiness for these activities. Four Lookouts and two small boats represent the maximum level of effort that the Navy can commit to observing mitigation zones for this activity given the number of personnel and assets available. To prevent these unacceptable impacts, the Navy recommends the measures below.

During activities using up to a 20 lb. net explosive weight (bin E6) detonation, the Navy will have four Lookouts and two small boats (two Lookouts positioned in each of the two boats). In addition, when aircraft are used, the pilot or member of the aircrew will serve as an additional Lookout. All divers placing the charges on mines will support the Lookouts while performing their regular duties. The divers will report all marine mammal and sea turtle sightings to their supporting small boat or Range Safety Officer.

5.3.1.2.2.6 Gunnery Exercises – Small- and Medium-Caliber Using a Surface Target

Lookout measures do not currently exist for small-and medium-caliber gunnery exercises using a surface target. The Navy is proposing to add this measure. The Navy will have one Lookout on the vessel or aircraft conducting small- and medium-caliber gunnery exercises against a surface target.

5.3.1.2.2.7 Gunnery Exercises – Large-Caliber Using a Surface Target

The Navy is proposing to clarify the number of Lookouts currently implemented for this activity. The Navy will have one Lookout on the ship conducting large-caliber gunnery exercises against a surface target.

5.3.1.2.2.8 Missile Exercises (Including Rockets) Up to 250 Pound Net Explosive Weight Using a Surface Target

The Navy is proposing to clarify the number of Lookouts currently implemented for this activity. When aircraft are conducting missile exercises up to 250 lb. net explosive weight against a surface target, the Navy will have one Lookout positioned in an aircraft.

5.3.1.2.2.9 Missile Exercises Using 251–500 Pound Net Explosive Weight Using a Surface Target

Lookout measures do not currently exist for missile exercises using 251–500 lb. net explosive weight. The Navy is proposing to add this measure. When aircraft are conducting missile exercises using 251–500 lb. net explosive weight against a surface target, the Navy will have one Lookout positioned in an aircraft.

5.3.1.2.2.10 Bombing Exercises

The Navy is proposing to clarify the number of Lookouts currently implemented for this activity. The Navy will have one Lookout positioned in an aircraft conducting bombing exercises.

5.3.1.2.2.11 Torpedo (Explosive) Testing

Lookout measures do not currently exist for torpedo (explosive) testing. The Navy is proposing to add this measure. The Navy will have one Lookout positioned in an aircraft during torpedo (explosive) testing.

5.3.1.2.2.12 Sinking Exercises

The Navy is proposing to continue using the number of Lookouts currently implemented for this activity. The Navy will have two Lookouts (one positioned in an aircraft and one on a surface vessel) during sinking exercises.

5.3.1.2.3 Physical Disturbance and Strike

5.3.1.2.3.1 Vessels

The Navy is proposing to clarify the mitigation measures currently implemented for this activity (including full power propulsion testing). While underway, vessels (other than minimally manned vessels) will have two Lookouts. Minimally manned vessels (ships less than 65 ft. [20 m] in length and ships that are minimally manned) will have a minimum of one Lookout.

5.3.1.2.3.2 Towed In-Water Devices

The Navy is proposing to clarify the number of Lookouts currently implemented for activities using towed in-water devices (e.g., towed mine neutralization). The Navy will have one Lookout during activities using towed in-water devices when towed from a manned platform.

5.3.1.2.3.3 Non-Explosive Practice Munitions – Small-, Medium-, and Large-Caliber Gunnery Exercises Using a Surface Target

The Navy is proposing to clarify the number of Lookouts currently implemented for these activities. The Navy will have one Lookout during activities involving non-explosive practice munitions (e.g., small-, medium-, and large-caliber gunnery exercises) against a surface target.

5.3.1.2.3.4 Non-Explosive Practice Munitions – Bombing Exercises

The Navy is proposing to clarify the number of Lookouts currently implemented for these activities. The Navy will have one Lookout positioned in an aircraft during non-explosive bombing exercises.

5.3.1.2.3.5 Non-Explosive Practice Munitions – Missile Exercises (Including Rockets) Using a Surface Target

The Navy is proposing to continue using the number of Lookouts currently implemented for these activities. When aircraft are conducting non-explosive missile exercises (including exercises using rockets) against a surface target, the Navy will have one Lookout positioned in an aircraft.

5.3.1.2.4 Effectiveness Assessment for Lookouts

Personnel standing watch in accordance with Navy standard operating procedures have multiple job responsibilities. While on duty, these standard watch personnel often conduct marine species observation in addition to their primary job duties (e.g., aiding in the navigation of the vessel). By having one or more Lookouts dedicated solely to observing the air and surface of the water during certain training and testing activities, the Navy increases the likelihood that marine species will be detected. It is also important to note that a number of training and testing activities involve multiple vessels and aircraft, thereby increasing the cumulative number of Lookouts or watch personnel that could potentially be present during a given activity.

Although using Lookouts is expected to increase the likelihood that marine species will be detected at the surface of the water, it is unlikely that using Lookouts will be able to help avoid impacts on all species entirely due to the inherent limitations of sighting marine mammals, as discussed in the sections below. Refer to Section 3.4.3.3 (Implementing Mitigation to Reduce Sound Exposures) for a quantitative discussion on the Navy's effectiveness assessment for Lookouts during sound-producing activities.

Pursuant to Phase I (e.g., Hawaii Range Complex EIS/OEIS) and in cooperation with NMFS, the Navy has undertaken monitoring efforts to track compliance with take authorizations, help evaluate the effectiveness of implemented mitigation measures, and gain a better understanding of the impacts of the Navy activities on marine resources. In 2010, the Navy initiated a study designed to evaluate the effectiveness of the Navy Lookout team. The University of St. Andrews, Scotland, under contract to the U.S. Navy, developed an initial data collection protocol for use during the study. Between 2010 and 2012, trained Navy marine mammal observers collected data during nine field trials as part of a "proof of concept" phase. The goal of the proof of concept phase was to develop a statistically valid protocol for quantitatively analyzing the effectiveness of Lookouts during Navy training exercises. Field trials were conducted in the Hawaii Range Complex, Southern California Range Complex, and Jacksonville Range Complex onboard one frigate, one cruiser, and seven destroyers. A preliminary analysis of the proof of concept data is ongoing. The Navy is also working to finalize the data collection process for use during the next phase of the study. While data was collected as part of this proof of concept phase, that data is not fairly comparable as protocols were being changed and assessed, nor is that data statistically significant. Therefore, it is improper to use this data to draw any conclusions on the effectiveness of Navy Lookouts.

5.3.1.2.4.1 Detection Probabilities of Marine Mammals in the Study Area

Until the results of the Navy's Lookout effectiveness study are available, the Navy must rely on the best available science to determine detection probabilities of marine mammals by Navy Lookouts. To do so, the Navy has compiled the results of available literature on line-transect analyses, which are typically used to estimate cetacean abundance. In line-transect analyses, the factors affecting the detection of an animal or group of animals directly on the transect line may be probabilistically quantified as g(0). As a reference, a g(0) value of 1 indicates that animals on the transect line are always detected. Table 5.3-1 provides detection probabilities for cetacean species based largely on g(0) values derived from shipboard and aerial surveys in the Study Area, which vary widely based on g(0) derivation factors (e.g., species, sighting platforms, group size, and sea state conditions). Refer to Section 3.4.3.3 (Implementing Mitigation to Reduce Sound Exposures) for additional background on g(0) and a discussion of how the Navy used g(0) to quantitatively assess the effectiveness of Lookouts during sound-producing activities.

Table 5.3-1: Detection Probability g(0) Values for Marine Mammal Species in the Mariana Islands Training and Testing Study Area

Species/Stocks	Family	Vessel Sightability	Aircraft Sightability
Baird's Beaked Whale	Ziphidae	0.96	0.18
Blainville's Beaked Whale	Ziphidae	0.40	0.074
Blue Whale, Fin Whale; Omura's Whale; Sei Whale	Balaenopteridae	0.921	0.407
Bottlenose Dolphin, Fraser's Dolphin	Delphinidae	0.808	0.96
Bryde's Whale	Balaenopteridae	0.91	0.407
Cuvier's Beaked Whale; Ginkgo-toothed Beaked Whale	Ziphidae	0.23	0.074
Dwarf Sperm Whale, Pygmy Sperm Whale, Kogia spp.	Kogiidae	0.35	0.074
False Killer Whale, Melon-headed Whale	Delphinidae	0.76	0.96
Humpback Whale	Balaenopteridae	0.921	0.495
Killer Whale	Delphinidae	0.91	0.96
Longman's Beaked Whale, Pygmy Killer Whale	Ziphidae, Delphinidae	0.76	0.074
Mesoplodon spp.	Ziphiidae	0.34	0.11
Minke Whale	Balaenopteridae	0.856	0.386
Northern Right Whale Dolphin	Delphinidae	0.856	0.96
Pantropical Spotted/Risso's/Rough	Delphinidae	0.76	0.96
Short-finned Pilot Whale	Delphinidae	0.76	0.96
Sperm Whale	Physeteridae	0.87	0.495

Note: For species having no data, the g(0) for Cuvier's aircraft value (where g(0)=0.074) was used; or in cases where there was no value for vessels, the g(0) for aircraft was used as a conservative underestimate of sightability following the assumption that the availability bias from a slower moving vessel should result in a higher g(0). Some g(0) values in the tables above are estimates of perception bias only, some are estimates of availability bias only, and some reflect both, depending on the species and data that are currently available.

Sources: Barlow 2010; Barlow and Forney 2007; Carretta et al. 2000

Several variables that play into how easily a marine mammal may be detected by a dedicated observer are directly related to the animal: including its external appearance and size; surface, diving and social behavior; and life history. The following is a generalized discussion of the behavior and external appearance of the marine mammals with the potential to occur in the Study Area as these characters relate to the detectability of each species. The species are grouped loosely based on either taxonomic relatedness or commonalities in size and behavior, and include large whales, cryptic species, and delphinids. Not all statements may hold true for all species in a grouping, and exceptions are mentioned where applicable. The information presented in this section may be found in Jefferson et al. (2008) and sources within unless otherwise noted (Jefferson et al. 2008).

Large Whales

Species of large whales found in the Study Area include all the baleen whales and the sperm whale. Baleen whales are generally large, with adults ranging in size from 30 to 89 ft. (9 to 27 m), often making them immediately detectable. Many species of baleen whales have a prominent blow ranging from 10 ft. (3 m) to as much as 39 ft. (12 m) above the surface. However, there are at least two species (Bryde’s whale and common minke whale) that often have no visible blow. Baleen whales tend to travel singly or in small groups ranging from pairs to groups of five. The exception to this is the fin whale, which is known to travel in pods of seven or more individuals. All species of baleen whales are known to form larger-scale aggregations in areas of high localized productivity or on breeding grounds. Baleen whales may or may not fluke at the surface before they dive; some species fluke regularly (e.g., the humpback whale), some fluke variably (e.g., the blue whale and fin whale) and some rarely fluke (e.g., the sei whale, common minke whale, and Bryde’s whale). Baleen whales may remain at the surface for extended periods of time as they forage or socialize. Humpback whales are known to corral prey at the surface. Dive behavior varies amongst species, as well. Many species will dive and remain at depth for as long as 30 minutes. Some will adjust their diving behavior according to the presence of vessels (e.g., the humpback whale and fin whale). Sei whales are known to sink just below the surface and remain there between breaths.

Sperm whales also belong to the large whales, with adult males reaching as much as 50 ft. (18 m) in total length. Sperm whales at the surface would likely be easy to detect. They have a prominent, 16 ft. (5 m) blow, and may remain at the surface for long periods of time. They are known to raft (i.e., loll at the surface) and to form surface-active groups when socializing. Sperm whales may travel or congregate in large groups of as many as 50 individuals. Although sperm whales engage in conspicuous surface behavior such as fluking, breaching, and tail-slapping, they are long, deep divers and may remain submerged for over 1 hour.

Cryptic Species

Cryptic and deep-diving species are those that do not surface for long periods of time and are often difficult to see when they surface, which ultimately limits the ability of observers to detect them even in good sighting conditions (Barlow et al. 2006). Cryptic species include beaked whales (family Ziphiidae), dwarf and pygmy sperm whales (*Kogia* species), and harbor porpoises. Beaked whales are notoriously difficult to detect at sea. In the Study Area, beaked whales may occur in a variety of group sizes, ranging from single individuals to groups of as many as 22 individuals (MacLeod and D'Amico 2006). Beaked whale diving behavior in general consists of long, deep dives that may last for nearly 90 minutes followed by a series of shallower dives and intermittent surfacings (Tyack et al. 2006, Baird et al. 2008). Some individuals remain at the surface for an extended period of time (perhaps 1 hour or more) or make shorter dives (MacLeod and D’Amico 2006). Detection of beaked whales is further complicated because beaked whales often dive and surface in a synchronous pattern and they travel below the surface of the water (MacLeod and D'Amico 2006).

Dwarf and pygmy sperm whales (referred to broadly as *Kogia* species) are small cetaceans (10–13 ft. [3–4 m] adult length) that are not commonly seen. *Kogia* species are some of the most commonly stranded species in some areas, which suggests that sightings are not indicative of their overall abundance. This supports the idea that they are cryptic, perhaps engaging in inconspicuous surface behavior or actively avoiding vessels. When *Kogia* species are sighted, they are typically seen in groups of no more than five to six individuals. They have no visible blow, do not fluke when they dive, and are known to log (i.e., lie motionless) at the surface. When they do dive, they often will sink out of sight with no prominent behavioral display.

Delphinids

Delphinids are some of the most likely species to be detected at sea by observers. Many species of delphinids engage in very conspicuous surface behavior, including leaping, spinning, bow riding, and traveling along the surface in large groups. Delphinid group sizes may range from 10 to 10,000 individuals, depending upon the species and the geographic region. Species such as pilot whales, rough-toothed dolphins, white-beaked dolphins, white-sided dolphins, bottlenose dolphins, stenellid dolphins, common dolphins, and Fraser's dolphins are known to either actively approach and investigate vessels, or bow ride along moving vessels. Fraser's dolphins and common dolphins form huge groups that travel quickly along the surface, churning up the water and making them visible from a great distance. Delphinids may dive for as little as 1 minute to more than 30 minutes depending upon the species.

5.3.1.2.4.2 Detection Probabilities of Sea Turtles in the Study Area

Sea turtles spend a majority of their time below the surface and are difficult to sight from a vessel until the animal is at close range (Hazel et al. 2007). Sea turtles often spend over 90 percent of their time underwater and are not visible more than 6.5 ft. (2 m) below the surface (Mansfield 2006). Sea turtles are generally much smaller than cetaceans, so while shipboard surveys designed for sighting marine mammals are adequate for detecting large sea turtles (e.g., adult leatherbacks), they are usually not adequate for detecting the smaller-sized turtles (e.g., juveniles and Kemp's ridleys). Juvenile sea turtles may be especially difficult to detect. Aerial detection may be more effective in spotting sea turtles on the surface, particularly in calm seas and clear water, but it is possible that the smallest age classes are not detected even in good conditions (Marsh and Saalfeld 1989). Visual detection of sea turtles, especially small turtles, is further complicated by their startle behavior in the presence of vessels. Turtles on the surface may dive below the surface of the water in the presence of a vessel before it is detected by shipboard or aerial observers (Kenney 2005). The detection probability of sea turtles is generally lower than that of cetaceans. The use of Lookouts for visual detection of sea turtles is likely effective only at close range, and is thought to be less effective for small individuals than large individuals.

5.3.1.2.4.3 Summary of Lookout Effectiveness

Due to the various detection probabilities, levels of Lookout experience, and variability of sighting conditions, Lookouts will not always be effective at avoiding impacts on all species. However, Lookouts are expected to increase the overall likelihood that certain marine mammal species and some sea turtles will be detected at the surface of the water, when compared to the likelihood that these same species would be detected if Lookouts are not used. The continued use of Lookouts contributes to helping reduce potential impacts on these species from training and testing activities.

5.3.1.2.5 Operational Assessment for Lookouts

As written, implementation of the mitigation measures recommended in Section 5.3.1.2 (Lookouts) has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activities, and Navy policy. The number of Lookouts recommended for each measure often represents the maximum Lookout capacity based on limited resources (e.g., space and manning restrictions).

5.3.2 MITIGATION ZONE PROCEDURAL MEASURES

Safety zones described in Section 5.1 (Standard Operating Procedures) are zones designed for human safety, whereas this section will introduce mitigation zones. A mitigation zone is designed solely for the purpose of reducing potential impacts on marine mammals and sea turtles from training and testing activities. Mitigation zones are measured as the radius from a source. Unique to each activity category, each radius represents a distance that the Navy will visually observe to help reduce injury to marine species. Visual detections of applicable marine species will be communicated immediately to the appropriate watch station for information dissemination and appropriate action. If the presence of marine mammals is detected acoustically, Lookouts posted in aircraft and on vessels will increase the vigilance of their visual surveillance. As a reference, aerial surveys are typically made by flying at 1,500 ft. (457 m) altitude or lower at the slowest safe speed.

Many of the proposed activities have mitigation measures that are currently being implemented, as required by previous environmental documents or consultations. Most of the current Phase I (e.g., Mariana Islands Range Complex [MIRC] EIS/OEIS) mitigation zones for activities that involve the use of impulse and non-impulse sources were originally designed to reduce the potential for onset of temporary threshold shift (TTS). For the MITT EIS/OEIS, the Navy updated the acoustic propagation modeling to incorporate updated hearing threshold metrics (i.e., upper and lower frequency limits), updated density data for marine mammals, and factors such as an animal's likely presence at various depths. An explanation of the acoustic propagation modeling process can be found in the *Determination of Acoustic Effects on Marine Mammals and Sea Turtles for the Mariana Islands Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement* technical report (Marine Species Modeling Team 2013).

As a result of the updates to the acoustic propagation modeling, in some cases, the ranges to onset of TTS effects are much larger than those output by previous Phase I models. Due to the ineffectiveness and unacceptable operational impacts associated with mitigating these large areas, the Navy is unable to mitigate for onset of TTS for every activity. In this MITT analysis, the Navy developed each recommended mitigation zone to avoid or reduce the potential for onset of the lowest level of injury, permanent threshold shift (PTS), out to the predicted maximum range. In some cases where the ranges to effects are smaller than previous models estimated, the mitigation zones were adjusted accordingly to provide consistency across the measures. Mitigating to the predicted maximum range to PTS consequently also mitigates to the predicted maximum range to onset mortality (1 percent mortality), onset slight lung injury, and onset slight gastrointestinal tract injury, since the maximum range to effects for these criteria are shorter than for PTS. Furthermore, in most cases, the predicted maximum range to PTS also consequently covers the predicted average range to TTS. Table 5.3-2 summarizes the predicted average range to TTS, average range to PTS, maximum range to PTS, and recommended mitigation zone for each activity category, based on the Navy's acoustic propagation modeling results.

The activity-specific mitigation zones are based on the longest range for all the functional hearing groups (based on the hearing threshold metrics described in Section 3.4, Marine Mammals, and Section 3.5, Sea Turtles). The mitigation zone for a majority of activities is driven by either the high-frequency cetaceans or the sea turtle functional hearing groups. Therefore, the mitigation zones are even more protective for the remaining functional hearing groups (i.e., low-frequency cetaceans and mid-frequency cetaceans) and likely cover a larger portion of the potential range to onset of TTS.

In some instances, the Navy recommends mitigation zones that are larger or smaller than the predicted maximum range to PTS based on the effectiveness and operational assessments. The recommended mitigation zones and their associated assessments are provided throughout the remainder of this section. The recommended measures are either currently implemented, modifications of current measures, or new measures.

Table 5.3-2: Predicted Range to Effects and Recommended Mitigation Zones

Activity Category	Representative Source (Bin)*	Predicted Average (Longest) Range to TTS	Predicted Average (Longest) Range to PTS	Predicted Maximum Range to PTS	Recommended Mitigation Zone
Non-Impulse Sound					
Low-frequency and Hull Mounted Mid-frequency Active Sonar	SQS-53 ASW hull-mounted sonar (MF1)	3,821 yd. (3.5 km) for one ping	100 yd. (91 m) for one ping	Not Applicable	6 dB power down at 1,000 yd. (914 m); 4 dB power down at 500 yd. (457 m); and shutdown at 200 yd. (183 m)
	Low-frequency sonar (LF4 and LF5)**	3,821 yd. (3.5 km) for one ping	100 yd. (91 m) for one ping	Not Applicable	200 yd. (183 m)**
High-frequency and Non-hull Mounted Mid-frequency Active Sonar	AQS-22 ASW dipping sonar (MF4)	230 yd. (210 m) for one ping	20 yd. (18 m) for one ping	Not applicable	200 yd. (183 m)
Explosive and Impulse Sound					
Improved Extended Echo Ranging Sonobuoys	Explosive sonobuoy (E4)	434 yd. (397 m)	156 yd. (143 m)	563 yd. (515 m)	600 yd. (549 m)
Explosive Sonobuoys using 0.6–2.5 lb. NEW	Explosive sonobuoy (E3)	290 yd. (265 m)	113 yd. (103 m)	309 yd. (283 m)	350 yd. (320 m)
Anti-swimmer Grenades	Up to 0.5 lb. NEW (E2)	190 yd. (174 m)	83 yd. (76 m)	182 yd. (167 m)	200 yd. (183 m)
Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices	NEW dependent (see Table 5.3-3)				
Mine Neutralization Activities Using Diver-Placed Time-Delay Firing Devices	Up to 20 lb. NEW (E6)	407 yd. (372 m)	98 yd. (90 m)	102 (93 m) yd.	1,000 yd. (915 m)
Gunnery Exercises – Small- and Medium-Caliber Using a Surface Target	40 mm projectile (E2)	190 yd. (174 m)	83 yd. (76 m)	182 yd. (167 m)	200 yd. (183 m)
Gunnery Exercises – Large-Caliber Using a Surface Target	5 in. projectiles (E5 at the surface***)	453 yd. (414 m)	186 yd. (170 m)	526 yd. (481 m)	600 yd. (549 m)
Missile Exercises (Including Rockets) up to 250 lb. NEW Using a Surface Target	Maverick missile (E9)	949 yd. (868 m)	398 yd. (364 m)	699 yd. (639 m)	900 yd. (823 m)
Missile Exercises from 251 to 500 lb. NEW Using a Surface Target	Harpoon missile (E10)	1,832 yd. (1,675 m)	731 yd. (668 m)	1,883 yd. (1,721 m)	2,000 yd. (1.8 km)
Bombing Exercises	MK-84 2,000 lb. bomb (E12)	2,513 yd. (2.3 km)	991 yd. (906 m)	2,474 yd. (2.3 km)	2,500 yd. (2.3 km)**
Torpedo (Explosive) Testing	MK-48 torpedo (E11)	1,632 yd. (1.5 km)	697 yd. (637 m)	2,021 yd. (1.8 km)	2,100 yd. (1.9 km)

Table 5.3-2: Predicted Range to Effects and Recommended Mitigation Zones (continued)

Activity Category	Representative Source (Bin)	Predicted Average Range to TTS	Predicted Average Range to PTS	Predicted Maximum Range to PTS	Recommended Mitigation Zone
Explosive and Impulse Sound					
Sinking Exercises	Various sources up to the MK-84 2,000 lb. bomb (E12)	2,513 yd. (2.3 km)	991 yd. (906 m)	2,474 yd. (2.3 km)	2.5 nm**

* This table does not provide an inclusive list of source bins; bins presented here represent the source bin with the largest range to effects within the given activity category.

** Recommended mitigation zones are larger than the modeled injury zones to account for multiple types of sources or charges being used.

*** The representative source bin E5 has different range to effects depending on the depth of activity occurrence (at the surface or at various depths).

Notes: ASW = Anti-submarine Warfare, km = kilometers, lb.= pound(s), mm= millimeters, m = meters, NEW = net explosive weight, nm= nautical miles, PTS = Permanent Threshold Shift, TTS = Temporary Threshold Shift, yd. = yards

Table 5.3-3: Predicted Range to Effects and Mitigation Zone Radius for Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices

Charge Size Net Explosive Weight (Bins)	General Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices*				Mine Countermeasure and Neutralization Activities Using Diver-Placed Charges under Positive Control**			
	Predicted Average Range to TTS	Predicted Average Range to PTS	Predicted Maximum Range to PTS	Recommended Mitigation Zone	Predicted Average Range to TTS	Predicted Average Range to PTS	Predicted Maximum Range to PTS	Recommended Mitigation Zone
2.6–5 lb. (E4)	434 yd. (397 m)	197 yd. (180 m)	563 yd. (515 m)	600 yd. (549 m)	545 yd. (498 m)	169 yd. (155 m)	301 yd. (275 m)	350 yd. (320 m)
6–10 lb. (E5)	525 yd. (480 m)	204 yd. (187 m)	649 yd. (593 m)	800 yd. (732 m)	587 yd. (537 m)	203 yd. (185 m)	464 yd. (424 m)	500 yd. (457 m)
11–20 lb. (E6)	766 yd. (700 m)	288 yd. (263 m)	648 yd. (593 m)	800 yd. (732 m)	647 yd. (592 m)	232 yd. (212 m)	469 yd. (429 m)	500 yd. (457 m)

* These mitigation zones are applicable to all mine countermeasure and neutralization activities conducted in all locations that Tables 2.8-1 through 2.8-5 specifies.

** These mitigation zones are only applicable to mine countermeasure and neutralization activities involving the use of diver placed charges. These activities are conducted in shallow-water and the mitigation zones are based only on the functional hearing groups with species that occur in these areas (mid-frequency cetaceans and sea turtles).

Notes: lb. = pounds, m = meters, PTS = Permanent Threshold Shift, TTS = Temporary Threshold Shift, yd. = yards

5.3.2.1 Acoustic Stressors

5.3.2.1.1 Non-Impulse Sound

5.3.2.1.1.1 Low-Frequency and Hull Mounted Mid-Frequency Active Sonar

Mitigation measures do not currently exist for low-frequency active sonar sources analyzed in this Draft EIS/OEIS, or new platforms or systems. The Navy is proposing to (1) add mitigation measures for low-frequency active sonar, (2) continue implementing the current measures for mid-frequency active sonar, and (3) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are below.

Training and testing activities that involve the use of low-frequency and hull-mounted mid-frequency active sonar (including pierside) will use Lookouts for visual observation from a ship immediately before and during the activity. With the exception of certain low-frequency sources that are not able to be powered down during the activity (e.g., low-frequency sources within bin LF4 and LF5), mitigation will involve powering down the sonar by 6 dB when a marine mammal or sea turtle is sighted within 1,000 yd. (914 m), and by an additional 4 dB when sighted within 500 yd. (457 m) from the source, for a total reduction of 10 dB. If the source can be turned off during the activity, active transmissions will cease if a marine mammal or sea turtle is sighted within 200 yd. (183 m).

Active transmission will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on its course speed, and the relative motion between the animal and the source; (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes; (4) the ship has transited more than 2,000 yd. (1.8 kilometer [km]) beyond the location of the last sighting; or (5) the ship concludes that dolphins are deliberately closing in on the ship to ride the ship’s bow wave (and there are no other marine mammal sightings within the mitigation zone). Active transmission may resume when dolphins are bow riding because they are out of the main transmission axis of the active sonar while in the shallow-wave area of the vessel bow.

If the source is not able to be powered down during the activity (e.g., low-frequency sources within bins LF4 and LF5), mitigation will involve ceasing active transmission if a marine mammal or sea turtle is sighted within 200 yd. (183 m). Active transmission will recommence if any one of the following conditions is met: (1) the animal is observed existing the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on its course, speed, and the relative motion between the animal and the source; (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes; or (4) the ship has transited more than 400 yd. (366 m) beyond the location of the last sighting.

<u>**Effectiveness and Operational Assessments**</u>

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted average range to onset of PTS for low-frequency and hull-mounted mid-frequency active sonar sources is 100 yd. (91 m) for one ping. This range was determined by the high-frequency cetacean functional hearing group. The distance for all other marine mammal functional hearing groups is less than 80 yd. (73 m) for one ping, so the mitigation zone will provide further protection from injury (PTS) for these species. Therefore, implementation of the 200 yd. (183 m) shutdown zone will reduce the potential for exposure to higher levels of energy that would result in injury (PTS) and large threshold shifts that are recoverable (i.e., TTS) when individuals are sighted. Implementation of the 500 yd. (457 m) and 1,000 yd. (914 m) sonar power reductions will further reduce the potential for injury (PTS) and larger threshold shifts that would result in recovery (i.e., TTS) to occur when individual marine mammals are sighted within these zones, especially in cases where the ship and animal are approaching each other.

The mitigation zones the Navy has developed are within a range for which Lookouts can reasonably be expected to maintain situational awareness and visually observe during most conditions. Since the predicted average range to onset of TTS is 3,821 yd. (3.5 km), the entire predicted range to TTS is not reasonably observable. By establishing mitigation zones that can be realistically maintained from ships, Lookouts will be more effective at sighting individual animals. By keeping Lookouts focused within the ranges where exposure to higher levels of energy is possible, the effectiveness at reducing potential impacts to marine mammals and sea turtles will increase. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), the likelihood of sighting individual animals, particularly sea turtles and some species of small or cryptic marine mammals, decreases at long distances. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts on marine mammals and sea turtles. Observations for sea turtles are required only during low-frequency active sonar activities because hull-mounted mid-frequency active sonar are not within the primary sea turtle hearing range.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30-minute wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.4.1 (Impacts from Sonar and Other Active Acoustic Sources) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 minutes would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would eliminate opportunities to detect submarines, objects, or other exercise targets as would be required in a real world combat situation, reduce the sonar operator's situational awareness of the environment where the training or testing is occurring, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.1.2 High-Frequency and Non-Hull Mounted Mid-Frequency Active Sonar

Mitigation measures do not currently exist for all high-frequency and non-hull mounted mid-frequency active sonar activities (i.e., new sources or sources not previously analyzed). The Navy is proposing to (1) continue implementing the current mitigation measures for activities currently being executed, such as dipping sonar activities; (2) extend the implementation of its current mitigation to all other activities in this category; and (3) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are provided below.

Mitigation will include visual observation from a vessel or aircraft (with the exception of platforms operating at high altitudes) immediately before and during active transmission within a mitigation zone of 200 yd. (183 m) from the active sonar source. For activities involving helicopter-deployed dipping sonar, visual observation will commence 10 minutes before the first deployment of active dipping sonar. If the source can be turned off during the activity, active transmission will cease if a marine mammal or sea turtle (for MF8, MF9, MF10, and MF12 only) is sighted within the mitigation zone. Active transmission will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes for an aircraft-deployed source, (4) the mitigation zone has been clear from any additional sightings for a period of 30 minutes for a vessel-deployed source, (5) the vessel or aircraft has repositioned itself more than 400 yd. (366 m) away from the location of the last sighting, or (6) the vessel concludes that dolphins are deliberately closing in to ride the vessel's bow wave (and there are no other marine mammal sightings within the mitigation zone).

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted average range to onset of PTS for high-frequency and non-hull mounted mid-frequency active sonar sources is 20 yd. (18 m) for one ping. This range was determined by the high-frequency cetacean functional hearing group. The predicted average range to onset of TTS across all functional hearing groups is 230 yd. (210 m) for one ping. Implementation of the 200 yd. (183 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury (PTS) and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. Lookouts often visually observe either close aboard a vessel or from directly above the source by aircraft (i.e., helicopters). Exceptions include when sonobuoys are deployed and when sources are deployed from high altitude aircraft. When sonobuoys are used, the sonobuoy field may be dispersed over a large distance. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), the likelihood of sighting individual animals, particularly sea turtles and some species of small or cryptic marine mammals, decreases at long distances. This measure should be effective at reducing the risk to all marine mammals and sea turtles that are available to be observed within the mitigation zone. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts on marine mammals and sea turtles. Observations for sea turtles are required only during non-hull-mounted mid-frequency active sonar activities within bins MF8, MF9, MF10, and MF12 because high-frequency active sonar and other bins of mid-frequency sonar are not within the primary sea turtle hearing range.

The post-sighting wait periods are designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 30-minute wait period for vessel-deployed sources more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving species. However, the analysis in Section 3.4.4.1.3 (Predicted Impacts from Sonar and Other Active Acoustic Sources) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur, with the exception of Kogia species. Requiring additional delay beyond 30 minutes for vessel-deployed sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would eliminate opportunities to detect submarines, objects, or other exercise targets that would be required during a real world combat situation and reduce the sonar operator's situational awareness of the environment where the training or testing is occurring, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10-minute wait period for aircraft-deployed sources covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10-minute wait period for aircraft-deployed sources is based on fuel restrictions for the types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 minutes for these sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would eliminate opportunities to detect submarines, objects, or other exercise targets as would be required during a real world combat situation and reduce the sonar operator's situational awareness of the environment where the training or testing is occurring, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2 Explosives and Impulse Sound

5.3.2.1.2.1 Improved Extended Echo Ranging Sonobuoys

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by reducing the marine mammal and sea turtle mitigation zone from 1,000 yd. (914 m) to 600 yd. (549 m), and (2) clarify the conditions needed to recommence an activity after a sighting for ease of implementation. The recommended measures are provided below.

Mitigation will include pre-exercise aerial observation and passive acoustic monitoring, which will begin 30 minutes before the first source/receiver pair detonation and continue throughout the duration of the exercise within a mitigation zone of 600 yd. (549 m) around an Improved Extended Echo Ranging sonobuoy. The pre-exercise aerial observation will include the time it takes to deploy the sonobuoy pattern (deployment is conducted by aircraft dropping sonobuoys in the water). Explosive detonations will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes.

Passive acoustic monitoring would be conducted with Navy assets, such as sonobuoys, already participating in the activity. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to Lookouts posted in aircraft and on vessels in order to increase vigilance of their visual observation.

<u>Effectiveness and Operational Assessments</u>

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for Improved Extended Echo Ranging sonobuoys is approximately 563 yd. (515 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 434 yd. (397 m). Implementation of the 600 yd. (549 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. The sonobuoy field may be dispersed over a large distance. As discussed in section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), the likelihood of sighting individual animals, particularly sea turtles and some species of small or cryptic marine mammals, decreases at long distances. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts on marine mammals and sea turtles.

The decrease in mitigation zone size will result in no mitigation for exposure to lower levels of potential onset of TTS; however, it will allow for a more focused survey effort over a smaller survey distance, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30-minute wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.4.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 minutes for aircraft-deployed Improved Extended Echo Ranging sonobuoys would modify the activity in a way that it would no longer meet its intended objective. The 30-minute wait period represents the maximum wait period acceptable for the type of aircraft involved in this activity (e.g., maritime patrol aircraft) based on fuel restrictions. Any additional delay would result in an unacceptable increased risk to personnel safety, require aircraft to depart the activity location to refuel, eliminate opportunities to detect submarines as would be required in a real world combat situation, and reduce the aircrew's situational awareness of the environment where the activity is occurring, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.2 Explosive Sonobuoys Using 0.6–2.5 Pound Net Explosive Weight

Mitigation measures do not currently exist for this activity. The Navy is proposing to add the recommended measures provided below.

Mitigation will include pre-exercise aerial monitoring during deployment of the field of sonobuoy pairs (typically up to 20 minutes) and continuing throughout the duration of the exercise within a mitigation zone of 350 yd. (320 m) around an explosive sonobuoy. Explosive detonations will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes.

Passive acoustic monitoring will also be conducted with Navy assets, such as sonobuoys, already participating in the activity. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to Lookouts posted in aircraft in order to increase vigilance of their visual observation.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for explosive sonobuoys using 0.6–2.5 lb. net explosive weight is approximately 309 yd. (283 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 290 yd. (265 m). Implementation of the 350 yd. (320 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and large threshold shifts that are recoverable (i.e., TTS) when individuals are sighted. The sonobuoy field may be dispersed over a large distance. As discussed in Section 5.3.1.2.5 (Effectiveness Assessment for Lookouts), the likelihood of sighting individual animals, particularly sea turtles and some species of small or cryptic marine mammals, decreases at long distances.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 10-minute wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10-minute wait period for aircraft-deployed sources is based on fuel restrictions for the types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 minutes for these sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would eliminate opportunities to detect and track submarines or other exercise targets as would be required in a real world combat situation, reduce the sonar operator's situational awareness of the environment where the training or testing is occurring, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.3 Anti-Swimmer Grenades

Mitigation measures do not currently exist for this activity. The Navy is proposing to add the recommended measures provided below.

Mitigation will include visual observation from a small boat immediately before and during the exercise within a mitigation zone of 200 yd. (183 m) around an anti-swimmer grenade. Explosive detonations will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes, or (4) the activity has been repositioned more than 400 yd. (366 m) away from the location of the last sighting.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for anti-swimmer grenades is approximately 182 yd. (167 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 190 yd. (174 m). Implementation of the 200 yd. (183 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shift that would result in recovery (i.e., TTS) when individuals are sighted. Since the Lookout is visually observing close aboard the boat, this measure should be effective at reducing the risk to all marine mammals and sea turtles that are available to be observed. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30-minute wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.4.2 (Impacts from Explosives) shows that injury to deep diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 minutes would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would eliminate opportunities for maritime security forces to detect, respond, to, and defend against enemy scuba divers as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.4 Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices

As Background, mine countermeasure and neutralization activities can be divided into two main categories: (1) general activities that can be conducted from a variety of platforms and locations, and (2) activities involving the use of diver-placed charges that typically occur close to shore. When either of these activities are conducted using a positive control firing device, the detonation is controlled by the personnel conducting the activity and is not authorized until the area is clear at the time of detonation. Refer to Section 5.3.3.1.1.1 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials with shallow coral reef, live hardbottom, artificial reef, and shipwreck mitigation areas.

Mitigation measures do not currently exist for general mine countermeasures and neutralization activities. The Navy is proposing to use the mitigation zones outlined in Table 5.3-3 during general mine countermeasure activities using positive control firing devices. General mine countermeasure and neutralization activity mitigation will include visual surveillance from small boats or aircraft beginning 30 minutes before, during, and 30 minutes after the completion of the exercise within the mitigation zones around the detonation site. Explosive detonations will cease if a marine mammal, sea turtle, flock of seabirds, or individual foraging seabird is sighted within the mitigation zone. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes.

For activities involving positive control diver-placed charges, the Navy is proposing to (1) modify the currently implemented mitigation measures for activities involving up to a 20 lb. net explosive weight detonation, and (2) clarify the conditions needed to recommence an activity after a sighting. For comparison, the currently implemented mitigation zone for general mine countermeasure and neutralization is 700 yd. (640 m) when using up to a 20 lb. net explosive weight charge. The recommended measures for activities involving positive control diver-placed activities are provided below.

The Navy is proposing to use the mitigation zones outlined in Table 5.3-3 during activities involving positive control diver-placed charges. Visual observation will be conducted by either two small boats, or one small boat in combination with one helicopter. Boats will position themselves near the mid-point of the mitigation zone radius (but always outside the detonation plume radius and human safety zone) and travel in a circular pattern around the detonation location. When using two boats, each boat will be positioned on opposite sides of the detonation location, separated by 180 degrees. If used, helicopters will travel in a circular pattern around the detonation location. Explosive detonations will cease if a marine mammal, sea turtle, flock of seabirds, or an individual foraging seabird is sighted in the water portion of the mitigation zone (i.e., not on shore). Lookouts will be trained to survey the mitigation zone for seabirds prior to and after the detonation event. During activities conducted in shallow water, a shore-based observer will use binoculars to survey the mitigation zone to detect any seabirds prior to and after each detonation. Detonations will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes (10 minutes for applicable helicopter activities).

Immediately following the detonation, visual monitoring (using binoculars) will be conducted to survey the mitigation zone for at least 30 minutes. The Navy will report all injured or dead seabirds sighted during the post-detonation observations to the appropriate Navy Region Environmental Director, Navy Pacific Fleet Environmental Office, and local base wildlife biologist.

For training exercises that include the use of multiple detonations, the second (or third, etc.) detonation will occur either immediately after the preceding detonation (i.e., within 10 seconds of the preceding detonation) or after 30 minutes have passed. This measure is intended to reduce the potential impacts to any piscivorous (fish-eating) birds, including least terns and pelicans, that forage in ocean waters or are attracted by stunned fish within the sphere of influence of the detonation.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. The predicted range to effects shown in Table 5.3-3 for general mine countermeasure and neutralization activities using positive control firing devices were determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had shorter ranges to onset of PTS, so the mitigation zones will provide further protection for these species. Implementation of the mitigation zones outlined in Table 5.3-3 will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

As described in Section 5.3.1 (Lookout Procedural Measures), Lookouts positioned in aircraft or small boats may be responsible for tasks in addition to observing the air or surface of the water. For example, a Lookout for this activity may also be responsible for navigation or assistance with mine countermeasure and neutralization deployment. The decrease in mitigation zone size for activities using diver-placed charges will result in no mitigation for exposure to lower levels of potential onset of TTS; however, it will allow for a more focused survey effort over a smaller area, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that result in recovery (i.e., TTS) to marine mammals. Having a Lookout observe a mitigation zone that is too large could potentially increase the safety risk due to an increased level of distraction from normal job duties. Observation of an area beyond what the Navy is proposing to implement would not be likely to result in avoidance or reduction of injury to marine mammals or sea turtles because the effort spent observing those more distant areas would inevitably be minimal.

As described in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), the ability of a Lookout to detect an animal can vary greatly based on what observing platform is being used. For large ranges, aerial observation is more effective. In addition, when observing from a small boat, sea turtle and cryptic marine mammal species can be very difficult to detect beyond a few meters. However, this measure should be effective at reducing potential impacts for individuals that are sighted.

Mine neutralization activities involving diver-placed charges occur primarily close to shore and in shallow water. The range to effects shown in Table 5.3-3 for mine neutralization activities involving diver-placed charges under positive control were determined by the sea turtle functional hearing group. The mid-frequency hearing group had shorter ranges to onset of PTS, so the mitigation zones will provide further protection for these species. However, mitigation would be implemented for any species observed within the mitigation zone.

Implementation of the mitigation zones outlined in Table 5.3-3 will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. The decrease in mitigation zone size for activities using diver-placed charges (up to 20 lb. net explosive weight charges) will result in no mitigation for exposure to lower levels of potential onset of TTS; however, it will allow for a more focused survey effort over a smaller area, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals.

During activities using diver-placed charges, Lookouts are visually observing from small boats or helicopters. As discussed above, aerial observation (and observations from shore-based platforms with high vantage points) is more effective than observation from a small boat. Since small boats do not have a very elevated observing platform, the distance over which animals can be observed is much shorter. Sea turtles and cryptic marine mammal species would be very difficult to detect further than a few meters away from the boat.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30-minute wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.4.2 (Impacts from Explosives) shows that injury to deep diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 minutes (when helicopters are not involved in the activity) would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would eliminate opportunities to detect, identify, evaluate, and neutralize mines as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10-minute wait period (when helicopters are involved in the activity) covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10-minute wait period is based on helicopter fuel restrictions. Requiring additional delay beyond 10 minutes for these sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would eliminate opportunities to detect, identify, evaluate, and neutralize mines, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of injury to most marine mammal species or seabirds; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.5 Mine Neutralization Diver-Placed Mines Using Time-Delay Firing Device

As background, when mine neutralization activities using diver-placed charges (up to a 29 lb. net explosive weight) are conducted with a time-delay firing device, the detonation is fused with a specified time-delay by the personnel conducting the activity and is not authorized until the area is clear at the time the fuse is initiated. During these activities, the detonation cannot be terminated once the fuse is initiated due to human safety concerns. Refer to Section 5.3.2.1.2.4 (Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices) for a general discussion of mitigation measures applicable to mine neutralization activities using diver-placed mines. This section will specify unique mitigation zones and observation methods for diver placed mine activities that use time-delay firing devices. Refer to Section 5.3.3.1.1.1 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef, live hardbottom, artificial reef, and shipwreck mitigation areas.

Mitigation measures do not currently exist for activities using diver-placed charges (up to a 20 lb. net explosive weight) with a time-delay firing device. The Navy is recommending the measures provided below.

The Navy is proposing to (1) modify the mitigation zones and observation requirements currently implemented for mine countermeasure and neutralization activities using diver-placed time-delay firing devices, and (2) clarify the conditions needed to recommence an activity after a sighting. For comparison, the current mitigation zones are based on size of charge and length of time-delay, ranging from a 1,000 yd. (914 m) mitigation zone for a 5 lb. net explosive weight charge using a 5-minute time-delay to a 1,500 yd. (1,372 m) mitigation zone for a 10 lb. net explosive weight charge using a 10-minute time-delay. The current requirement is six Lookouts in three boats (two in each boat) for larger than 1,400 yd. (1,280 m) and four Lookouts in two small boats to be used for observation in mitigation zones that are less than 1,400 yd. (1,280 m). The recommended measures for activities involving diver-placed time-delay firing devices are provided below.

The Navy recommends one mitigation zone for all net explosive weights and lengths of time-delay. Mine neutralization activities involving diver-placed charges will not include time-delay longer than 10 minutes. Mitigation will include visual surveillance from small boats or aircraft commencing 30 minutes before, during, and until 30 minutes after the completion of the exercise within a mitigation zone of 1,000 yd. (915 m) around the detonation site. During activities using time-delay firing devices involving up to a 20 lb. net explosive weight charge, visual observation will take place using two small boats. In addition, when aircraft are involved (e.g., during deployment of divers), the pilot or member of the aircrew will serve as an additional Lookout. The fuse initiation will cease if a marine mammal, sea turtle, or flock of seabirds or individual foraging seabird is sighted within the water portion of the mitigation zone (i.e., not on shore). Fuse initiation will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes.

Survey boats will position themselves near the mid-point of the mitigation zone radius (but always outside the detonation plume radius/human safety zone) and travel in a circular pattern around the detonation location. One Lookout from each boat will look inward toward the detonation site and the other Lookout will look outward away from the detonation site. Each boat will be positioned on opposite sides of the detonation location, separated by 180 degrees. If available for use, helicopters will travel in a circular pattern around the detonation location.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-3, the predicted maximum range to onset of PTS for mine neutralization diver-placed mines using time-delay firing devices is approximately 469 yd. (429 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 647 yd. (592 m). The time-delay firing device mitigation zone was determined by including additional distance on top of the predicted maximum range to onset of PTS to account for a portion of the time that a marine mammal or sea turtle could enter the mitigation zone during the time-delay. Implementation of the 1,000 yd. (915 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

A 1,000 yd. (915 m) mitigation zone represents the maximum distance that the Lookouts on small boats can adequately observe given the number of personnel that will be involved. As discussed in Section 5.3.1.2.2.5 (Mine Neutralization Activities Using Diver-Placed Time-Delay Firing Devices), the use of more than two small boats for observation during this activity presents an unacceptable impact on readiness due to limited personnel resources. Since small boats do not have an elevated observing platform, the distance over which animals can be observed is much shorter. Sea turtles and cryptic marine mammal species would be very difficult to detect further than a few meters away from the boat. Sighting a sea turtle is only likely if a helicopter is participating in the activity. In addition, even with the extended mitigation zone to account for as much of the time-delay as possible, there is still a remote chance that animals may swim into the area after the charge is already set. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30-minute wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.4.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. The 30-minute wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. Requiring additional delay beyond 30 minutes would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would eliminate opportunities to detect, identify, evaluate, and neutralize mines as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measures described above because (1) they are likely to result in avoidance or reduction of injury to most marine mammal species; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.6 Gunnery Exercises – Small- and Medium-Caliber Using a Surface Target

Mitigation measures do not currently exist for small- and medium-caliber gunnery using a surface target. Refer to Section 5.3.3.1.1.1 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

Mitigation will include visual observation from a vessel or aircraft immediately before and during the exercise within a mitigation zone of 200 yd. (183 m) around the intended impact location. Vessels will observe the mitigation zone from the firing position. When aircraft are firing, the aircrew will maintain visual watch of the mitigation zone during the activity. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes for a firing aircraft, (4) the mitigation zone has been clear from any additional sightings for a period of 30 minutes for a firing vessel, and (5) the intended target location has been repositioned more than 400 yd. (366 m) away from the location of the last sighting.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for small-and medium-caliber gunnery is approximately 182 yd. (167 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The average range to onset of TTS across all functional hearing groups is 190 yd. (174 m). Implementation of the 200 yd. (183 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

Small- and medium-caliber gunnery exercises involve the participating vessel or aircraft firing munitions at a target location that may be up to 4,000 yd. (3.7 km) away, although typically much closer than this. Therefore, it is necessary for the Lookout to be able to visually observe the mitigation zone from varying distances. Large vessel or aircraft platforms would provide a more effective observation platform for Lookouts than small boats. However, as discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 4,000 yd. (3.7 km). However, this measure is likely effective at reducing the risk of injury to marine mammals that may be observed from the typical target distances. This measure may be ineffective at reducing the risk of injury to sea turtles at large target distances; however, it does reduce the risk for those individuals that may be observed at closer distances. In addition, it is more likely that sea turtles will be observed when exercises involve aircraft versus vessels. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 30-minute wait period for a firing vessel more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.4.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 minutes for a firing vessel would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10-minute wait period for a firing aircraft covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10-minute wait period is based on fuel restrictions for the types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 minutes for these sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would eliminate opportunities and reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to some marine mammal species; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.7 Gunnery Exercises – Large-Caliber Using a Surface Target

The Navy is proposing to (1) continue using the currently implemented mitigation zone for this activity, (2) clarify the conditions needed to recommence an activity after a sighting, and (3) modify the seafloor habitat mitigation area. Refer to Section 5.3.3.1.1.1 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

Mitigation will include visual observation from a ship immediately before and during the exercise within a mitigation zone of 600 yd. (549 m) around the intended impact location. Ships will observe the mitigation zone from the firing position. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for large caliber gunnery is approximately 526 yd. (481 m). This range was determined by the high-frequency cetacean functional hearing group. The remaining functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The average predicted range to onset of TTS across all functional hearing groups is 453 yd. (414 m). Implementation of the 600 yd. (549 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shift that would result in recovery (i.e., TTS) when individuals are sighted. Per the Navy's current reporting requirements, any injured or dead marine mammals or sea turtles will be reported as appropriate.

Large-caliber gunnery exercises involve the participating ship firing munitions at a target location from ranges up to 6 nautical miles (nm) away. Therefore it is necessary for the Lookout to be able to visually observe the mitigation zone from this distance. Although the Lookout will observe for all marine mammals or sea turtles in the area, as discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen. Although this measure is likely ineffective at reducing the risk of injury to sea turtles and some species of marine mammals, it does reduce the risk for those individuals that may be observed. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30-minute wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.4.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 minutes would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to some marine mammal species; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.8 Missile Exercises (Including Rockets) up to 250 Pound Net Explosive Weight Using a Surface Target

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by reducing the mitigation zone from 1,800 yd. (1.6 km) to 900 yd. (823 m), (2) clarify the conditions needed to recommence an activity after a sighting, and (3) modify the platform of observation to eliminate the requirement to observe when ships are firing. Refer to Section 5.3.3.1.1.1 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

When aircraft are firing, mitigation will include visual observation by the aircrew or supporting aircraft prior to commencement of the activity within a mitigation zone of 900 yd. (823 m) around the deployed target. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes or 30 minutes (depending on aircraft type).

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for a missile exercise ([including rockets] up to 250 lb. net explosive weight [bin E9]) is approximately 699 yd. (639 m). This range was determined by the sea turtle functional hearing group. The marine mammal functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 949 yd. (868 m). Implementation of the 900 yd. (823 m) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted. The decrease in mitigation zone size will result in no mitigation for exposure to lower levels of potential onset of TTS; however, it will allow for a more focused survey effort over a smaller survey distance, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals and sea turtles.

Missile exercises involve the participating ship or aircraft firing munitions at a target location typically up to 15 nm away and infrequently include ranges up to 75 nm away. When an aircraft is firing, the aircraft can travel close to the intended impact area so that it can be visually observed. Because this type of observation is not possible for a ship, visual observation is not suitable for activities that involve a ship-fired missile. Even with aircraft firing, there is a chance that animals could enter the impact area after the visual observations have been completed and the activity has commenced. Therefore, this measure is not effective at reducing the risk of injury to animals once the firing has begun; however, it does reduce the risk for those individuals that may be observed prior to commencement of the activity when aircraft are firing. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 30-minute wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. The 30-minute wait period represents the maximum wait period acceptable for certain types of aircraft involved in this activity (e.g., maritime patrol aircraft) based on their specific fuel restrictions. Requiring additional delay beyond 30 minutes for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch missiles as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10-minute wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10-minute wait period is based on the specific fuel restrictions for the other types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 minutes for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch missiles as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.9 Missile Exercises from 251 to 500 Pound Net Explosive Weight Using a Surface Target

The Navy is proposing to modify the mitigation measures currently implemented for this activity by increasing the mitigation zone from 1,800 yd. (1.6 km) to 2,000 yd. (1.8 km). Refer to Section 5.3.3.1.1.1 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

When aircraft are firing, mitigation will include visual observation by the aircrew or supporting aircraft prior to commencement of the activity within a mitigation zone of 2,000 yd. (1.8 km) around the intended impact location. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes or 30 minutes (depending on aircraft type).

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for a missile exercise using 251–500 lb. net explosive weight (bin E10) is approximately 1,883 yd. (1.7 km). This range was determined by the sea turtle functional hearing group. The marine mammal functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 1,832 yd. (1.7 km). Implementation of the 2,000 yd. (1.8 km) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

Missile exercises involve the participating ship or aircraft firing munitions at a target location typically up to 15 nm away and infrequently include ranges up to 75 nm away. When an aircraft is firing, the aircraft can travel close to the intended impact area so that it can be visually observed. Because that type of observation is not possible for a ship, visual observation is not suitable for activities that involve a ship-fired missile. Even with aircraft firing, there is a chance that animals could enter the impact area after the visual observations have been completed and the activity has commenced. Therefore, this measure is not effective at reducing the risk of injury to animals once the firing activity has begun; however, it does reduce the risk for those individuals that may be observed prior to commencement of the activity when aircraft are firing. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 30-minute wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. The 30-minute wait period represents the maximum wait period acceptable for certain types of aircraft involved in this activity (e.g., maritime patrol aircraft) based on their specific fuel restrictions. Requiring additional delay beyond 30 minutes for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch missiles as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10-minute wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10-minute wait period is based on the specific fuel restrictions for the other types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 minutes for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and launch missiles as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity readiness, and Navy policy.

5.3.2.1.2.10 Bombing Exercises

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by increasing the mitigation zone from 1,000 yd. (914 m) to 2,500 yd. (2.3 km), and (2) clarify the conditions needed to recommence an activity after a sighting. Refer to Section 5.3.3.1.1.1 (Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks) for information on mitigation designed to avoid or reduce potential impacts from military expended materials within shallow coral reef mitigation areas. The recommended measures are provided below.

Mitigation will include visual observation from the aircraft immediately before the exercise and during target approach within a mitigation zone of 2,500 yd. (2.3 km) around the intended impact location. Bombing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Bombing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes.

<u>**Effectiveness and Operational Assessments**</u>

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for bombing exercises is approximately 2,474 yd. (2.3 km). This range was determined by the sea turtle functional hearing group. The marine mammal functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. For example, the predicted maximum range to onset of PTS to mid-frequency of cetaceans is less than 500 yd. (457 m). The average range to onset of TTS across all functional hearing groups is 2,513 yd. (2.3 km). Implementation of the 2,500 yd. (2.3 km) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

The predicted maximum range to onset mortality across all functional hearing groups is less than 250 yd. (229 m). Therefore, this measure will be effective at reducing potential mortality to all marine mammals and sea turtles when individuals are sighted. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 2,500 yd. (2.3 km) near the perimeter of the mitigation zone. However, this measure is likely effective at reducing the risk of injury to marine mammals and sea turtles that may be observed from the smaller distances within the mitigation zone. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts to marine mammals and sea turtles.

As described in Section 5.3.1 (Lookout Procedural Measures), Lookouts positioned in aircraft may be responsible for tasks in addition to observing the air or surface of the water. For example, a Lookout for this activity may also be responsible for navigation of the aircraft. Having a Lookout observe a mitigation zone that is too large could potentially increase the safety risk due to an increased level of distraction from normal job duties. Similarly, Lookouts posted in aircraft during bombing activities will, by necessity, focus their attention on the water surface below and surrounding the location of bomb deployment. Due to the nature of this activity (e.g., aircraft maintaining a relatively steady altitude of approximately 1,500 ft. [457 m] and approaching the intended impact location), Lookouts will be able to observe a larger area during bombing activities than other proposed activities that involve the use of Lookouts positioned in aircraft (e.g., Improved Extended Echo Ranging sonobuoy activities). However, observation of an area beyond what the Navy is proposing to implement for bombing activities is not practicable and would not likely result in avoidance or reduction of injury to marine mammals or sea turtles because the effort spent observing those more distant areas would inevitably be minimal.

While the increase in mitigation zone size will not mitigate for exposures to lower levels of potential onset of TTS, it will allow for a more focused survey effort over a larger survey distance and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 10-minute wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10-minute wait period is based on fuel restrictions (factoring in the typical activity locations) for the types of aircraft involved in this activity (e.g., F/A-18). Requiring additional delay beyond 10 minutes for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and deliver bombs as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.11 Torpedo (Explosive) Testing

Mitigation measures do not currently exist for torpedo (explosive) testing. The Navy is recommending the measures provided below.

Mitigation will include visual observation by aircraft (with the exception of platforms operating at high altitudes) immediately before, during, and after the exercise within a mitigation zone of 2,100 yd. (1.9 km) around the intended impact location. Firing will cease if a marine mammal, sea turtle, or aggregation of jellyfish is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes or 30 minutes (depending on aircraft type)

In addition to visual observation, passive acoustic monitoring would be conducted with Navy assets, such as passive ships sonar systems or sonobuoys, already participating in the activity. Passive acoustic observation would be accomplished through the use of remote acoustic sensors or expendable sonobuoys, or via passive acoustic sensors on submarines when they participate in the Proposed Action. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to the Lookout posted in the aircraft in order to increase vigilance of the visual surveillance and to the person in control of the activity for their consideration in determining when the mitigation zone is determined free of visible marine mammals.

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for explosive torpedoes is approximately 2,021 yd. (1.8 km). This range was determined by the sea turtle functional hearing group. The marine mammal functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. The predicted average range to onset of TTS across all functional hearing groups is 1,632 yd. (1.5 km). Implementation of the 2,100 yd. (1.9 km) mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

The predicted maximum range to onset mortality across all functional hearing groups is less than 600 yd. (549 m). Therefore, this measure will be effective at reducing potential mortality to all marine mammals and sea turtles when individuals are sighted. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 2,100 yd. (1.9 km) near the perimeter of the mitigation zone. However, this measure is likely effective at reducing the risk of injury to marine mammals and sea turtles that may be observed from the smaller distances within the mitigation zone. Observation for indicators of marine mammal and sea turtle presence (e.g., jellyfish aggregations) will further help avoid impacts to marine mammals and sea turtles.

As described in Section 5.3.1 (Lookout Procedural Measures), Lookouts positioned in aircraft may be responsible for tasks in addition to observing the air or surface of the water. For example, a Lookout for this activity may also be responsible for navigation of the aircraft. Having a Lookout observe a mitigation zone that is too large could potentially increase the safety risk due to an increased level of distraction from normal job duties. Observation of an area beyond what the Navy is proposing to implement for torpedo (explosive) testing activities is not practicable and would not likely result in avoidance or reduction of injury to marine mammals or sea turtles because the effort spent observing those more distant areas would inevitably be minimal.

While the increase in mitigation zone size will not mitigate for exposures to lower levels of potential onset of TTS; it will allow for a more focused survey effort over a larger survey distance, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 10-minute wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10-minute wait period is based on fuel restrictions (factoring in the typical activity locations) for the types of aircraft involved in this activity (e.g., F/A-18). Requiring additional delay beyond 10 minutes for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and deliver bombs as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.12 Sinking Exercises

The Navy is proposing to (1) modify the mitigation measures currently implemented for this activity by increasing the mitigation zone from 2.0 nm to 2.5 nm, (2) clarify the conditions needed to recommence an activity after a sighting, and (3) adopt the marine mammal and sea turtle mitigation zone size for aggregations of jellyfish for ease of implementation. The recommended measures are provided below.

Mitigation will include visual observation within a mitigation zone of 2.5 nm around the target ship hulk. Sinking exercises will include aerial observation beginning 90 minutes before the first firing, visual observations from vessels throughout the duration of the exercise, and both aerial and vessel observation immediately after any planned or unplanned breaks in weapons firing of longer than 2 hours. Prior to conducting the exercise, the Navy will review remotely sensed sea surface temperature and sea surface height maps to aid in deciding where to release the target ship hulk.

The Navy will also monitor using passive acoustics during the exercise. Passive acoustic monitoring would be conducted with Navy assets, such as passive ships sonar systems or sonobuoys, already participating in the activity. These assets would only detect vocalizing marine mammals within the frequency bands monitored by Navy personnel. Passive acoustic detections would not provide range or bearing to detected animals, and therefore cannot provide locations of these animals. Passive acoustic detections would be reported to Lookouts posted in aircraft and on vessels in order to increase vigilance of their visual surveillance. Lookouts will also increase observation vigilance before the use of torpedoes or unguided ordnance with a net explosive weight of 500 lb. or greater, or if the Beaufort sea state is a 4 or above.

The exercise will cease if a marine mammal, sea turtle, or aggregation of jellyfish is sighted within the mitigation zone. The exercise will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes. Upon sinking the vessel, the Navy will conduct post-exercise visual surveillance of the mitigation zone for 2 hours (or until sunset, whichever comes first).

Effectiveness and Operational Assessments

See the introduction of Section 5.3.2 (Mitigation Zone Procedural Measures) for a general discussion of mitigation zones, how they are implemented, and the potential impacts they are designed to reduce. During a sinking exercise, multiple weapons sources may be used (projectiles, missiles, bombs, torpedoes), the largest of which is the 2,000 lb. bomb. The recommended mitigation zone is approximately double the predicted maximum range to onset of PTS of the largest weapon source, and is designed to account for multiple detonations during the activity. As shown in Table 5.3-2, the predicted maximum range to onset of PTS for a bombing exercise is approximately 2,474 yd. (2.3 km). This range was determined by the sea turtle functional hearing group. The marine mammal functional hearing groups had a shorter predicted range to onset of PTS, so the mitigation zone will provide further protection for these species. For example, the predicted maximum range to onset of PTS to mid-frequency of cetaceans is less than 500 yd. (457 m). The predicted average range to onset of TTS across all functional hearing groups is 2,513 yd. (2.3 km). Implementation of the 2.5 nm mitigation zone will reduce the potential for exposure to higher levels of energy that would result in injury and larger threshold shifts that would result in recovery (i.e., TTS) when individuals are sighted.

The predicted maximum range to onset mortality across all functional hearing groups is less than 250 yd. (229 m). Therefore, this measure will be effective at reducing potential mortality to all marine mammals and sea turtles when individuals are sighted. As discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 2,100 yd. (1.9 km) near the perimeter of the mitigation zone. However, this measure is likely effective at reducing the risk of injury to marine mammals and sea turtles that may be observed from the smaller distances within the mitigation zone.

As described in Section 5.3.1 (Lookout Procedural Measures), Lookouts positioned in aircraft or vessels may be responsible for tasks in addition to observing the air or surface of the water. For example, a Lookout for this activity may also be responsible for navigation of the aircraft. Having a Lookout observe a mitigation zone that is too large could potentially increase the safety risk due to an increased level of distraction from normal job duties. Observation of an area beyond what the Navy is proposing to implement for sinking exercises is not practicable and would not likely result in avoidance or reduction of injury to marine mammals or sea turtles because the effort spent observing those more distant areas would inevitably be minimal. The decrease in mitigation zone size will result in no mitigation for exposure to lower levels of potential onset of TTS; however, it will allow for a more focused survey effort over a smaller survey distance, and will consequently increase the likelihood of avoidance of injury and larger threshold shifts that would result in recovery (i.e., TTS) to marine mammals and sea turtles. The amount of time it takes for an aircraft to conduct line transects around a detonation point within the currently implemented 4.5 nm mitigation zone could result in animals entering the mitigation zone at one end while the aircraft completes the survey at the other end of the mitigation zone. Observation for indicators of marine mammal and sea turtle presence (e.g., jellyfish aggregations) will further help avoid impacts to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30-minute wait period more than covers the average dive times of most marine mammal species but may not be sufficient for some deep-diving marine mammal species or for sea turtles. However, the analysis in Section 3.4.4.2 (Impacts from Explosives) shows that injury to deep-diving marine mammals (e.g., sperm whales and beaked whales) is not expected to occur. Requiring additional delay beyond 30 minutes would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the ship and aircrews' abilities to coordinate attack tactics on a seaborne target as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise. Although activities involving certain types of aircraft (e.g., helicopters) typically employ a 10-minute wait period due to fuel restrictions, the Navy is able to make an exception for this particular activity due to the large variation and rotation of assets that could participate in this type of exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.1.2.13 Weapons Firing Noise During Gunnery Exercises – Large-Caliber

The Navy is proposing to implement the following mitigation measure, which only applies to the firing side of the ship as provided below.

For all explosive and non-explosive large-caliber gunnery exercises conducted from a ship, mitigation will include visual observation immediately before and during the exercise within a mitigation zone of 70 yd. (64 m) within 30 degrees on either side of the gun target line on the firing side. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes, or (4) the vessel has repositioned itself more than 140 yd. (128 m) away from the location of the last sighting.

Effectiveness Assessment

The mitigation zone is designed to reduce the potential for injury from weapons firing noise during large-caliber gunnery exercises conducted from a ship. The majority of the energy that an animal could be exposed to would occur on the firing side of the vessel and would follow in the direction of fire. It is not operationally feasible to have Lookouts stationed on all sides of the vessel to visually observe for marine mammals and sea turtles due to limited resources (e.g., manning restrictions). Since the Lookout is positioned aboard the firing ship and is visually observing nearby the ship (70 yd. [64 m]), this measure should be effective at reducing the risk to all marine mammals and sea turtles that are available to be observed. Observation for indicators of marine mammal and sea turtle will further help avoid impacts on marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30-minute wait period more than covers the average dive times of most marine mammal species but may not be sufficient for sea turtles. However, the analysis in Section 3.4.4.2.5 (Impacts from Weapons Firing, Launch, and Impact Noise) shows that injury to marine mammals is not expected to occur. Requiring additional delay beyond 30 minutes would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because (1) it is likely to result in avoidance or reduction of exposure to high levels of energy to marine mammals and sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.2 Physical Disturbance and Strike

5.3.2.2.1 Vessels and In-Water Devices

5.3.2.2.1.1 Vessels

The Navy is proposing to clarify using the mitigation measures currently implemented. The recommended measures are provided below.

Vessels will avoid approaching marine mammals head on and will maneuver to maintain a mitigation zone of 500 yd. (457 m) around observed whales, and 200 yd. (183 m) around all other marine mammals (except bow-riding dolphins), providing it is safe to do so.

Effectiveness and Operational Assessments

Since the Lookout is visually observing within a reasonable distance of the vessel (within 500 yd. [457 m]), this measure should be effective at reducing the risk to marine mammals that are available to be observed. However, as discussed above in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), large whales and pods of dolphins are more likely to be seen than other more cryptic species, such as beaked whales.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of injury to marine mammals; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.2.1.2 Towed In-Water Devices

The Navy is proposing to implement the recommended measures provided below.

The Navy will ensure that towed in-water devices being towed from manned platforms avoid coming within a mitigation zone of 250 yd. (229 m) around any observed marine mammal, providing it is safe to do so.

Effectiveness and Operational Assessments

Since the Lookout is visually observing within a reasonable distance of the vessel (250 yd. [229 m]), this measure should be effective at reducing the risk to marine mammals that are available to be observed. However, as discussed above in Section 5.3.1.2.5 (Effectiveness Assessment for Lookouts), large whales and pods of dolphins are more likely to be seen than other more cryptic species such as beaked whales.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of injury to marine mammals; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.2.2 Non-Explosive Practice Munitions

5.3.2.2.2.1 Gunnery Exercises – Small-, Medium-, and Large-Caliber Using a Surface Target

The Navy is proposing to (1) continue using the mitigation measures currently implemented for this activity, and (2) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are provided below.

Mitigation will include visual observation from a vessel or aircraft immediately before and during the exercise within a mitigation zone of 200 yd. (183 m) around the intended impact location. Firing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Firing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes for a firing aircraft, (4) the mitigation zone has been clear from any additional sightings for a period of 30 minutes for a firing vessel, or (5) the intended target location has been repositioned more than 400 yd. (366 m) away from the location of the last sighting.

Effectiveness and Operational Assessments

The mitigation zone is designed to reduce the potential for direct strike from a non-explosive projectile. Large-caliber gunnery exercises involve the participating ship firing munitions at a target location from ranges up to 6 nm away. Small- and medium-caliber gunnery exercises involve the participating vessel or aircraft firing munitions at a target location from up to 2 nm away, although typically closer. Therefore it is necessary for the Lookout to be able to visually observe the mitigation zone from these distances. Although the Lookout will observe for all marine mammals or sea turtles in the area, as discussed in Section 5.3.1.2.4 (Effectiveness Assessment for Lookouts), it is highly unlikely that anything but a whale blow or large pod of dolphins will be seen at distances closer to 6 nm or 2 nm at the furthest target distances. Although this measure is likely ineffective at reducing the risk of injury to sea turtles and some species of marine mammals, it does reduce the risk for those individuals that may be observed. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts to marine mammals and sea turtles.

The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. A 30-minute wait period when vessels are firing more than covers the average dive times of most marine mammal species but may not be for sea turtles. However, the analysis in Section 3.4.4.4.3 (Impacts from Military Expended Materials) shows that injury to marine mammals and sea turtles is not expected to occur. Requiring additional delay beyond 30 minutes for a firing vessel would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The 10-minute wait period for a firing aircraft covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10-minute wait period is based on fuel restrictions for the types of aircraft involved in this activity (e.g., helicopters). Requiring additional delay beyond 10 minutes for these sources would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would eliminate opportunities and reduce the gun crews' abilities to engage surface targets and practice defensive marksmanship as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of injury to some species of marine mammals; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.2.2.2.2 Bombing Exercises

The Navy is proposing to (1) continue using the mitigation measures currently implemented for this activity, and (2) clarify the conditions needed to recommence an activity after a sighting. The recommended measures are provided below.

Mitigation will include visual observation from the aircraft immediately before the exercise and during target approach within a mitigation zone of 1,000 yd. (914 m) around the intended impact location. Bombing will cease if a marine mammal or sea turtle is sighted within the mitigation zone. Bombing will recommence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on a determination of its course and speed and the relative motion between the animal and the source, or (3) the mitigation zone has been clear from any additional sightings for a period of 10 minutes.

Effectiveness and Operational Assessments

The mitigation zone is designed to reduce the potential for direct strike from a non-explosive bomb. The post-sighting wait period is designed to give any animals that are sighted an opportunity to leave the area before the exercise recommences but will only be employed if one of the other conditions has not already been met. The 10-minute wait period covers a portion of the average marine mammal and sea turtle dive times but may not be sufficient to cover the average dive times of all species. The 10-minute wait period is based on fuel restrictions for the types of aircraft involved in this activity (e.g., F/A-18). Requiring additional delay beyond 10 minutes for these platforms would modify the activity in a way that it would no longer meet its intended objective. Any additional delay would result in an unacceptable increased risk to personnel safety or would require aircraft to depart the activity location to refuel, which would reduce the aircrews' abilities to approach surface targets and deliver bombs as would be required in a real world combat situation, and would therefore have an unacceptable impact on the realism and effectiveness of the exercise. Observation for indicators of marine mammal and sea turtle presence will further help avoid impacts on marine mammals and sea turtles.

The Navy proposes implementing the recommended measure described above because: (1) it is likely to result in avoidance or reduction of injury to marine mammals or sea turtles; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.3 Mitigation Areas

The Navy is proposing to implement several mitigation measures within pre-defined habitat areas in the Study Area. For the purposes of this document, the Navy will refer to these areas as "mitigation areas." As described throughout this section, these recommended mitigation areas may be based off endangered species critical habitats, endangered species reproductive areas, or bottom features. The size and location of certain habitat areas, such as the critical habitats, is subject to change over time;

however, the Navy's effectiveness and operational assessments, and resulting mitigation recommendations are entirely dependent on the mitigation area defined in this document. Therefore, it is important to note that the Navy is recommending implementing mitigation measures only within each area as described in this document. Applying these mitigations to additional or expanded areas could potentially result in an unacceptable impact on readiness.

Of note, the Marianas Trench Marine National Monument protects approximately 95,216 square miles of submerged lands and waters. Although the restrictions placed on the monument do not apply to military readiness activities, the Armed Forces shall ensure, by the adoption of appropriate measures not impairing operations or operational capabilities, that its vessels and aircraft act in a manner consistent, so far as is reasonable and practicable, with this proclamation (6 January 2009).

5.3.3.1 Seafloor Resources

5.3.3.1.1 Marine Habitats and Cultural Resources

5.3.3.1.1.1 Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks

The Navy is proposing to: (1) modify some of the mitigation measures for seafloor habitats and shipwrecks, and (2) discontinue the currently implemented measures for medium- and large-caliber gunnery exercises and missile exercises using airborne targets.

The shipwreck data documented in the Marine Habitat chapter were refined to only accurate positions using the following criteria: (1) not an obstruction, sounding, unknown (non-wreck), dump site, mooring buoy, sewer outfall, piling, or rock; (2) high or medium accuracy location; (3) not disproved; (4) not an approximate position (applied to medium accuracy only); and (5) source information provided.

The Navy will not conduct precision anchoring within the anchor swing diameter, or explosive mine countermeasure and neutralization activities (except in existing anchorages and near-shore training areas around Guam and within Apra Harbor) within 350 yd. (320 m) of surveyed shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks.

The Navy will not conduct explosive or non-explosive small-, medium-, and large-caliber gunnery exercises using a surface target, explosive missile exercises using a surface target, or explosive and non-explosive bombing exercises within 350 yd. (320 m) of surveyed shallow coral reefs.

<u>Effectiveness and Operational Assessments</u>

The Navy's currently implemented seafloor habitats and shipwreck mitigation zones are based off the range to effects for marine mammals or sea turtles, which are driven by hearing thresholds. The Navy's recommended measures are modified to focus on reducing potential physical impacts to seafloor habitats and shipwrecks from explosives and physical strike military expended materials. The recommended 350 yd. (320 m) mitigation zone is based off the estimated maximum seafloor impact zone for explosions discussed in Section 3.3 (Marine Habitats). The use of non-explosive military expended materials would result in a smaller footprint of potential impact; however, the Navy recommends applying the explosive mitigation zone to all explosive and non-explosive activities as listed above for ease of implementation. This standard mitigation zone will consequently result in an additional protection buffer during the non-explosive activities listed above.

It is not possible to definitively predict or to effectively monitor where the military expended materials from airborne gunnery and missile exercises using aerials targets would be likely to strike seafloor habitats and shipwrecks. The potential debris fall zone can only be predicted within tens of miles for long range events, which can be in excess of 80 nm from the firing location during some missile exercises, and thousands of yards for shorter events, which can occur within several thousand yards of the firing location.

Live hardbottom, shallow water coral reefs, artificial reefs, and shipwrecks fulfill important ecosystem functions. Avoiding or minimizing physical disturbance and strike of these resources will likely reduce the impact on these resources. This measure is only effective with regard to surveyed resources since the Navy needs specific locations to restrict the specified activities. It is not possible for the Navy to avoid these seafloor features when their exact locations are unknown.

The Navy proposes implementing the recommended measures described above because (1) they are likely to result in avoidance or reduction of physical disturbance and strike to seafloor habitats and shipwrecks; and (2) implementation has been analyzed as acceptable with regard to personnel safety, practicality of implementation, impact on effectiveness of the military readiness activity, and Navy policy.

5.3.4 Mitigation Measures Considered but Eliminated

A number of mitigation measures were suggested during the public comment periods of previous Navy environmental documents. As a result of the assessment process identified in Section 5.2 (Introduction to Mitigation), the Navy determined that some of the suggested measures would likely be ineffective at reducing environmental impacts, have an unacceptable operational impact based on the operational assessment, or be incompatible with Section 5.2.2 (Overview of Mitigation Approach). The measures that the Navy does not recommend for implementation are discussed in Section 5.3.4.1 (Previously Considered by Eliminated) and Section 5.3.4.2 (Previously Accepted but Now Eliminated). There is a distinction between effective and feasible observation procedures for data collection and measures employed to prevent impacts or otherwise serve as mitigation. The discussion below is in reference to those procedures meant to serve as mitigation measures.

5.3.4.1 Previously Considered but Eliminated

5.3.4.1.1 Reducing Amount of Training and Testing Activities

Reducing training and testing for the purpose of mitigation would result in an unacceptable impact on readiness for the following reasons:

The requirements to train are designed to provide the experience needed to ensure Sailors are properly prepared for operational success. Training requirements have been developed through many years of iteration and are designed to ensure Sailors achieve the levels of readiness needed to properly respond to the many contingencies that may occur during an actual mission. The Proposed Action does not include training beyond levels required for maintaining satisfactory levels of readiness due to the need to efficiently use limited resources (e.g., fuel, personnel, and time). Therefore, any reduction of training would not allow Sailors to achieve satisfactory levels of readiness needed to accomplish their mission.

The requirements to test systems prior to their implementation in military activities are identified in Department of Defense (DoD) Directive 5000.1. This directive states that test and evaluation support is to be integrated throughout the defense acquisition process. The Navy rigorously collected data during the developmental stages of this EIS/OEIS to accurately quantify test activities necessary to meet requirements of DoD Directive 5000.1. These testing requirements are designed to determine whether systems perform as expected and are operationally effective, suitable, survivable, and safe for their intended use. Any reduction of testing activities would not allow the Navy to meet its purpose and need to achieve requirements set forth in DoD Directive 5000.1.

5.3.4.1.2 Replacing Training and Testing with Simulated Activities

Replacing training and testing activities with simulated activities for the purpose of mitigation would result in an unacceptable impact on readiness for the reasons below.

As described in Section 2.5.1.3 (Simulated Training and Testing), the Navy currently uses computer simulation for training and testing whenever possible. Computer simulation can provide familiarity and complement live training; however, it cannot provide the fidelity and level of training necessary to prepare naval forces for deployment.

The Navy is required by law to operationally test major platforms, systems, and components of these platforms and systems in realistic combat conditions before full-scale production can occur. Substituting simulation for live training and testing fails to meet the purpose of and need for the Proposed Action and therefore was eliminated from consideration as a mitigation measure.

5.3.4.1.3 Reducing Sonar Source Levels and Total Number of Hours

Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform’s presence. Passive sonar and all other sensors are used in concert with active sonar to the maximum extent practicable when available and when required by the mission. Reducing active sonar source levels and the total number of active sonar hours used during training and testing activities for the purpose of mitigation would adversely impact the effectiveness of military readiness activities and increase safety risks to personnel for the reasons below.

Sonar operators need to train as they would operate during real combat situations. Operators of sonar equipment are always cognizant of the environmental variables affecting sound propagation. In this regard, sonar equipment power levels are always set consistent with mission requirements. Reducing sonar source levels for the purpose of mitigation precludes sonar operators from learning to operate the sonar systems with their entire range of capabilities throughout the extremely diverse range of environmental conditions they may encounter. Failure to train with the entire range of capabilities will reduce the effectiveness of the sonar operators should their skills be required during real world events. Not only would they not develop the skills necessary to identify and track submarines at the maximum distances of their systems capabilities, they would not learn how to use their systems’ capabilities during the entire range of environmental conditions they may encounter. Likewise, they would not develop the knowledge of how to fully integrate multiple anti-submarine warfare capabilities, including other ships and aircraft into an integrated anti-submarine warfare team.

Failure to train with the entire range of capabilities also compromises training by reducing the ability for a sonar operator to detect, track, and hold an enemy target, mine, or other object, and by reducing the realism of other training scenarios (e.g., navigation training). Particularly during a strike group exercise, sonar operators need to learn to handle real world combat situations (e.g., the ability to manage sonar operations during periods of mutual interference, which can occur when more than one sonar system is operating simultaneously). Training with reduced sonar source levels would ultimately condition Sailors to expect conditions that they would not experience in a real world combat situation, thereby resulting in an unacceptable increased risk to personnel safety and the strike group’s ability to achieve mission success. The Navy must test its systems in the same way they would be used for military readiness activities. Reducing sonar source levels during testing would impact the ability to determine whether systems are operationally effective, suitable, survivable, and safe. Ultimately, reducing sonar source levels would reduce training and testing realism. Reducing the total number of sonar hours used during training and testing would prevent the Navy from meeting its military readiness qualification standards.

5.3.4.1.4 Implementing Active Sonar Ramp-Up Procedures During Training

Implementing active sonar ramp-up procedures (slowly increasing the sound in the water to necessary levels) in an attempt to clear the range prior to conducting activities for the purpose of mitigation during training activities would result in an unacceptable impact on readiness for the reasons below.

Ramp-up procedures would alert opponents to the participants' presence. This would consequently negatively affect the realism of training because the target submarine could detect the searching unit before the searching unit could detect the target submarine, enabling the target submarine to take evasive measures. This is not representative of a real-world situation and thereby would impact training realism and effectiveness. Training with reduced realism would alter Sailors' abilities to effectively operate in a real world combat situation, thereby resulting in an unacceptable increased risk to personnel safety and the sonar operator's ability to achieve mission success.

Although ramp-up procedures have been used for some testing activities, effectiveness at avoiding or reducing impacts on marine mammals has not been demonstrated. Until evidence suggests that ramp-up procedures are effective means of avoiding or reducing potential impacts on marine mammals, the Navy is proposing to eliminate the implementation of this measure for testing activities as part of the Proposed Action.

5.3.4.1.5 Reducing Vessel Speed

As described in Section 5.1.1 (Vessel Safety), as a standard operating procedure, Navy personnel are required to use extreme caution and operate at a slow, safe speed consistent with mission and safety. These standard operating procedures are designed to allow a vessel to take proper and effective action to avoid a collision with any sighted object or disturbance (which may include a marine mammal), and to stop within a distance appropriate to the prevailing circumstances and conditions. Implementing widespread reductions in vessel speed throughout the Study Area for the purpose of mitigation would be impractical with regard to military readiness activities, and result in an unacceptable impact on readiness for the reasons below.

Vessel operators need to be able to react to changing tactical situations and evaluate system capabilities in training and testing as they would in actual combat. Widespread speed restrictions would not allow the Navy to properly test vessel capabilities, for example, during full power propulsion testing during sea trials. Training with reduced realism would alter Sailors' abilities to effectively operate in a real world combat situation, thereby resulting in an unacceptable increased risk to personnel safety and the vessel operator's ability to achieve mission success.

5.3.4.1.6 Limiting Access to Training and Testing Locations

Limiting training and testing activities to specific locations for the purpose of mitigation would be impractical with regard to implementation, would adversely impact the effectiveness of military readiness activities, and would increase safety risks to personnel for the reasons below.

As described in Section 2.5.1.1 (Alternative Training and Testing Activity Locations), the ability to use the diverse and multidimensional capabilities of each range complex and testing range results in the Navy's ability to develop and maintain high levels of readiness. Major exercises using integrated warfare components require large areas of the littorals, open ocean, and certain nearshore areas for realistic and safe training. Limiting training and testing (including the use of sonar and other active acoustic sources or explosives) to specific locations (e.g., abyssal waters and surveyed offshore waters) and avoiding areas (e.g., embayments or large areas of the littorals and open ocean) would be impractical to implement with regard to the need to conduct activities in proximity to certain facilities and range complexes. These restrictions would also adversely impact the safety of the training and testing activities by requiring activities to take place in more remote areas where safety support may be limited.

Training and testing activities require continuous access to large areas consisting potentially of thousands of square miles of ocean and air space to provide naval personnel the ability to train with and develop competence and confidence in their capabilities and their entire suite of weapons and sensors. Exercises may change mid-stream based on evaluators' assessments of performance and other conditions including weather or mechanical issues. These may preclude use of a permission scheme for access to water space. Threats to national security are constantly evolving and the Navy requires the ability to adapt training to meet these emerging threats as well as develop and test systems to effectively operate in these environments. Restricting access to limited locations would impact the ability of Navy training and testing to evolve as the threat evolves. Operational units already incorporate requirements for safety of personnel including air space and shipping routes. Safety restrictions may include limits on distance from military air fields during carrier flight operations and air traffic corridors for safety of military and civilian aviation. These types of limitations shape how exercise planners develop and implement training scenarios including those involving defense of aircraft carriers from submarines.

Therefore, limiting access to training and testing locations would reduce realism of training by restricting access to important real world combat situations, such as bathymetric features and varying oceanographic features. As described in Section 5.3.4.1.7 (Avoiding Locations Based on Bathymetry and Environmental Conditions), Sailors must be trained to handle bottom bounce, sound passing through changing currents, eddies, or across changes in ocean temperature, pressure, or salinity. Training in a few specific locations would alter Sailors' abilities to effectively operate in varying real world combat situations, thereby resulting in an unacceptable increased risk to personnel safety and the ability to achieve mission success.

5.3.4.1.7 Avoiding Locations Based on Bathymetry and Environmental Conditions

Avoiding locations for training and testing activities based on bathymetry and environmental conditions for the purpose of mitigation would increase safety risks to personnel and result in an unacceptable impact on readiness for the reasons below.

Areas where training and testing activities are scheduled to occur are carefully chosen to provide safety and allow realism of events. As described in Section 2.5.1.1 (Alternative Training and Testing Activity Locations), the varying environmental conditions of the Study Area (e.g., bathymetry and topography) maximize the training realism and testing effectiveness. Limiting training and testing (including the use of sonar and other active acoustic sources or explosives) to avoid steep or complex bathymetric features (e.g., submarine canyons and large seamounts) and oceanographic features (e.g., surface fronts and variations in sea surface temperatures) would reduce the realism of the military readiness activity. Systems must be tested in a variety of bathymetric and environmental conditions to ensure functionality and accuracy in a variety of environments. Sonar operators need to train as they would operate during real world combat situations. Because real world combat situations include diverse bathymetric and environmental conditions, Sailors must be trained to handle bottom bounce, sound passing through changing currents, eddies, or across changes in ocean temperature, pressure, or salinity. Training with reduced realism would alter Sailors' abilities to effectively operate in a real world combat situation, thereby resulting in an unacceptable increased risk to personnel safety and the sonar operator's ability to achieve mission success.

5.3.4.1.8 Avoiding or Reducing Active Sonar at Night and During Periods of Low Visibility

Avoiding or reducing active sonar at night and during periods of low visibility for the purpose of mitigation would result in an unacceptable impact on readiness for the reasons below.

The Navy must train in the same manner as it will fight. Anti-submarine warfare can require a significant amount of time to develop the "tactical picture," or an understanding of the battle space (e.g., area searched or unsearched, identifying false contacts, and understanding the water conditions). Reducing or securing power in low-visibility conditions would affect a commander's ability to develop this tactical picture and would not provide the needed training realism. Training differently from what would be needed in an actual combat scenario would decrease training effectiveness, reduce the crew's abilities, and introduce an increased safety risk to personnel.

Mid-frequency active sonar training is required year-round in all environments, including night and low-visibility conditions. Training occurs over many hours or days, which requires large teams of personnel working together in shifts around the clock to work through a scenario. Training at night is vital because environmental differences between day and night affect the detection capabilities of sonar. Temperature layers that move up and down in the water column and ambient noise levels can vary significantly between night and day, which affects sound propagation and could affect how sonar systems are operated. Consequently, personnel must train during all hours of the day to ensure they identify and respond to changing environmental conditions, and not doing so would unacceptably decrease training effectiveness and reduce the crews' abilities. Therefore, the Navy cannot operate only in daylight hours or wait for the weather to clear before training.

The Navy must test its systems in the same way they would be used for military readiness activities. Reducing or securing power in adverse weather conditions or at night would impact the ability to determine whether systems are operationally effective, suitable, survivable, and safe. Additionally, some systems have a nighttime testing requirement. Therefore, Navy personnel cannot operate only in daylight hours or wait for the weather to clear before or during all test events.

5.3.4.1.9 Avoiding or Reducing Active Sonar during Strong Surface Ducts

Avoiding or reducing active sonar during strong surface ducts for the purpose of mitigation would increase safety risks to personnel, be impractical with regard to implementation of military readiness activities, and result in an unacceptable impact on readiness for the reasons below.

The Navy must train in the same manner as it will fight. Anti-submarine warfare can require a significant amount of time to develop the "tactical picture," or an understanding of the battle space such as area searched or unsearched, identifying false contacts, understanding the water conditions, etc. Surface ducting is a condition when water conditions (e.g., temperature layers, lack of wave action) result in little sound energy penetrating beyond a narrow layer near the surface of the water. Submarines have long been known to exploit the phenomena associated with surface ducting. Therefore, training in surface ducting conditions is a critical component to military readiness because sonar operators need to learn how sonar transmissions are altered due to surface ducting, how submarines may take advantage of them, and how to operate sonar effectively in this environment. Avoiding or reducing active sonar during surface ducting conditions would affect a commander's ability to develop this tactical picture and would not provide the needed training realism. Diminished realism would reduce a sonar operator's ability to effectively operate in a real world combat situation, thereby resulting in an unacceptable increased risk to personnel safety and the ability to achieve mission success.

Furthermore, avoiding surface ducting would be impractical to implement because ocean conditions contributing to surface ducting change frequently, and surface ducts can be of varying duration. Surface ducting can also lack uniformity and may or may not extend over a large geographic area, making it difficult to determine where to reduce power and for what periods.

5.3.4.1.10 Avoiding Locations Based on Distances from Isobaths or Shorelines

Avoiding locations for training and testing activities within the Study Area based on wide-scale distances from isobaths or the shoreline for the purpose of mitigation would be impractical with regard to implementation of military readiness activities, result in unacceptable impact on readiness, and would not be an effective means of mitigation, and would increase safety risks to personnel for the reasons below.

A measure requiring avoidance of mid-frequency active sonar within 13 nm of the 656 ft. (200 m) isobaths was part of the Rim of the Pacific Exercise 2006 authorization by NMFS. This measure, as well as similar measures of like distances, lacks any scientific basis when applied to the context of the MITT Study Area (e.g., bathymetry, sound propagation, and width of channels). There is no scientific analysis indicating this measure is protective and no known basis for these specific metrics. The Rim of the Pacific 2006 exercise mitigation measure precluded active anti-submarine training in the littoral region, which significantly impacted realism and training effectiveness (e.g., protecting ships from submarine threats during amphibious landings). This mitigation procedure had no observable effect on the protection of marine mammals during Rim of the Pacific 2006 exercises, and its value is unclear; however, its adverse effect on realistic training, as with all arbitrary distance from land restrictions, is significant.

Training in shallower water is an essential component to maintaining military readiness. Sound propagates differently in shallower water and operators must learn to train in this environment. Additionally, submarines have become quieter through the use of improved technology and have learned to hide in the higher ambient noise levels of the shallow waters of coastal environments. In real world events, it is highly likely Sailors would be working in, and therefore must train in, these types of areas.

Areas where training and testing activities are scheduled to occur are carefully chosen to provide safety and allow realism of events. The proximity to facilities, range complexes, and testing ranges is essential to the training and testing realism and effectiveness required to train and certify naval forces ready for combat operations. Limiting access to nearshore areas would restrict access to certain training and testing locations and would increase transit time for these activities, which would result in an increased risk to personnel safety, particularly for platforms with fuel restrictions (e.g., aircraft) or for certain activities such as mine countermeasures and neutralization activities using diver-placed mines.

The ability to use the diverse and multi-dimensional capabilities of each range complex and testing range results in the Navy's ability to develop and maintain high levels of readiness. Otherwise limiting training and testing (including the use of sonar and other active acoustic sources or explosives) to avoid arbitrary distances from isobaths or the shoreline would adversely impact the effectiveness of the training and testing. This includes avoiding conducting activities within 12 nm from shore, 25 nm from shore, between shore and the 20 m isobath, and 13 nm out from the 656 ft. (200 m) isobath. Operating in shallow water is essential in order to provide realistic training on real world combat conditions with regard to shallow water sound propagation.

5.3.4.1.11 Avoiding Marine Species Habitats

Navy has recommended measures within several mitigation areas (Section 5.3.3, Mitigation Areas) that have been well-documented as important habitats for particular species and in which implementation of mitigation would not result in unacceptable impacts on readiness. These mitigation areas have been carefully selected on a case-by-case basis through consultation with NMFS and the U.S. Fish and Wildlife Service. Otherwise avoiding all marine species habitats (e.g., foraging locations, reproductive locations, migration corridors, and locations of modeled takes) for the purpose of mitigation would be impractical with regard to implementation of military readiness activities, would result in unacceptable impact on readiness, and would increase safety risks to personnel for the reasons below.

As described in Section 5.3.4.1.6 (Limiting Access to Training and Testing Locations) and Section 5.3.4.1.7 (Avoiding Locations Based on Bathymetry and Environmental Conditions), areas where training and testing activities are scheduled to occur are carefully chosen to provide safety and allow realism of events, and the varying environmental conditions of these areas maximize the training realism and testing effectiveness. Activity locations inevitably overlap a wide array of marine species habitats, including foraging habitats, reproductive areas, and migration corridors. Otherwise limiting activities to avoid these habitats would adversely impact the effectiveness of the training or testing activity, and would therefore result in an unacceptable increased risk to personnel safety and the ability to achieve mission success.

Proposed mitigation includes protective measures within several areas (Section 5.3.3, Mitigation Areas) that have been well documented as important habitats for particular species. The measures outlined in Section 5.3.1 (Lookout Procedural Measures) and Section 5.3.2 (Mitigation Zone Procedural Measures) have been developed to reduce potential impacts on marine species regardless of activity location.

As described in the *Determination of Acoustic Effects on Marine Mammals and Sea Turtles for the Mariana Islands Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement* technical report (Marine Species Modeling Team 2013), modeling locations were developed based on historical data and anticipated future needs. The model does not provide information detailed enough to analyze or compare locations based on potential take levels for each activity; therefore, applying the modeling results to inform development of mitigation areas would not be appropriate.

5.3.4.1.12 Increasing Visual and Passive Acoustic Observations

Increasing visual and passive acoustic observations for the purpose of mitigation would be impractical with regard to implementation of military readiness activities and result in unacceptable impact on readiness for the reasons below.

The Navy recommended mitigation measures already represent the maximum level of effort (e.g., numbers of Lookouts and passive sonobuoys) that the Navy can commit to observing mitigation zones given the number of personnel that will be involved and the number and type of assets and resources available. The number of Lookouts that the Navy recommends for each measure often represents the maximum capacity based on limited resources (e.g., space and manning restrictions). Furthermore, training and testing activities are carefully planned with regard to personnel duties. Requiring additional

Lookouts would either require adding personnel, for which there would be no additional space, or reassigning duties, which would divert Navy personnel from essential tasks required to meet mission objectives.

The Navy will conduct passive acoustic monitoring during several activities with Navy assets, such as sonobuoys, already participating in the activity (e.g., sinking exercises, torpedo [explosive] testing, and improved extended echo ranging sonobuoys). Refer to Section 5.3.2 (Mitigation Zone Procedural Measures) for additional information on the use of passive acoustics during training and testing activities. The Navy does not have the resources to construct and maintain additional passive acoustic monitoring systems for each training and testing activity.

5.3.4.1.13 Increasing the Size of Observed Mitigation Zones

Increasing the size of observed mitigation zones for the purpose of mitigation would be impractical with regard to implementation of military readiness activities and result in unacceptable impact on readiness for the reasons below.

The Navy developed activity-specific mitigation zones based on the Navy's acoustic propagation model. In this MITT analysis, the Navy developed each recommended mitigation zone to avoid or reduce the potential for onset of the lowest level of injury, PTS, out to the predicted maximum range. Mitigating to the predicted maximum range to PTS consequently also mitigates to the predicted maximum range to onset mortality (1 percent mortality), onset slight lung injury, and onset slight gastrointestinal tract injury, since the maximum range to effects for these criteria are shorter than for PTS. Furthermore, in most cases, the predicted maximum range to PTS also covers the predicted average range to TTS. In some instances, the Navy recommends mitigation zones that are larger or smaller than the predicted maximum range to PTS based on the associated effectiveness and operational assessments presented in Section 5.3.2 (Mitigation Zone Procedural Measures).

The Navy recommended mitigation zones represent the maximum area the Navy can effectively observe based on the platform of observation, number of personnel that will be involved, and the number and type of assets and resources available. As mitigation zone sizes increase, the potential for reducing impacts decreases. For instance, if a mitigation zone increases from 1,000 to 4,000 yd. (914 to 3,658 m), the area that must be observed increases 16-fold. The Navy recommended mitigation measures balance the need to reduce potential impacts with the ability to provide effective observations throughout a given mitigation zone. Implementation of mitigation zones is most effective when the zone is appropriately sized to be realistically observed. The Navy does not have the resources to maintain additional Lookouts or observer platforms that would be needed to effectively observe mitigation zones of increased size. Further, as explained above, the number of Lookouts that the Navy recommends for each measure often represents the maximum capacity based on limited resources (e.g., space and manning restrictions). For example, platforms such as the Littoral Combat Ship are minimally manned and are therefore physically unable to accommodate more than one Lookout. Training and testing activities are carefully planned with regard to personnel duties. Requiring observation of mitigation zones of increased size would either require adding personnel, for which there would be no additional space or resources, or reassigning duties, which would divert Navy personnel from essential tasks required to meet mission objectives. For most activities, Lookouts are required to observe for indicators of potential marine mammal and sea turtle presence within the mitigation zone to further help reduce the potential for injury to occur.

5.3.4.1.14 Conducting Visual Observations Using Third-Party Observers

With limited exceptions, use of third-party observers (e.g., trained marine species observers) in air or on surface platforms in addition to existing Navy Lookouts for the purposes of mitigation would be impractical with regard to implementation of military readiness activities and result in unacceptable impact on readiness for the reasons below.

Navy personnel are extensively trained in spotting items on or near the water surface. Use of Navy Lookouts ensures immediate implementation of mitigation if marine species are sighted. A critical skill set of effective Navy training is communication. Navy Lookouts are trained to act swiftly and decisively to ensure that appropriate actions are taken. Additionally, multiple training and testing events can occur simultaneously and in various regions throughout the Study Area, and can last for days or weeks at a time. The Navy does not have the resources to maintain third-party observers to accomplish the task for every event.

The use of third-party observers would compromise security for some activities involving active sonar due to the requirement to provide advance notification of specific times and locations of Navy platforms. Reliance on the availability of third-party personnel would impact training and testing flexibility. The presence of other aircraft in the vicinity of naval activities would raise safety concerns for both the commercial observers and naval aircraft. Furthermore, vessels have limited passenger capacity. Training and testing event planning includes careful consideration of this limited capacity in the placement of personnel on ships involved in the event. Inclusion of non-Navy observers onboard these vessels would require that in some cases there would be no additional space for essential Navy personnel required to meet the exercise objectives.

The areas where training events will most likely occur in the Study Area cover approximately 1 million square nautical miles. Contiguous anti-submarine warfare events may cover many hundreds or even thousands of square miles. The number of civilian vessels or aircraft required to monitor the area of these events would be considerable. It is, thus, not feasible to survey or monitor the large exercise areas in the time required. In addition, marine mammals may move into or out of an area, if surveyed before an event, or an animal could move into an area after an event took place. Given that there are no adequate controls to account for these or other possibilities, there is little utility to performing extensive before or after event surveys of large exercise areas as a mitigation measure.

Surveying during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, many of the training and testing events take place far from land, limiting both the time available for civilian aircraft to be in the event area and presenting a concern should aircraft mechanical problems arise. Scheduling civilian vessels or aircraft to coincide with training events would impact training effectiveness, since exercise event timetables cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the progress of the exercise and impact the effectiveness of the military readiness activity.

5.3.4.1.15 Adopt Mitigation Measures of Foreign Nation Navies

Adopting mitigation measures of foreign navies generally for the purpose of mitigation, such as expanding the mitigation zones to match those used by a particular foreign navy, would be impractical with regard to implementation of military readiness activities and result in unacceptable impact on readiness for the reasons below.

Mitigation measures are carefully customized for and agreed upon by each individual navy based on potential impacts of the activities on marine species and the impacts of the mitigation measures on military readiness. Therefore, the mitigation measures developed for one navy would not necessarily be effective at reducing potential impacts on marine species by all navies. Similarly, mitigation measures that do not cause an unacceptable impact on one navy may cause an unacceptable impact on another. For example, most other navies do not possess an integrated strike group and do not have integrated training requirements. The Navy's training is built around the integrated warfare concept and is based on the Navy's capabilities, the threats faced, the operating environment, and the overall mission. Implementing other navies' mitigation would be incompatible with U.S. Navy requirements. The U.S. Navy's recommended mitigation measures have been carefully designed to reduce potential impacts on marine species while not causing an unacceptable impact on readiness.

5.3.4.1.16 Increasing Reporting Requirements

The Navy has extensive reporting requirements, including exercise and monitoring reporting designed to verify implementation of mitigation, comply with current permits, and improve future environmental assessments (Section 5.5.2, Reporting). Increasing the requirement to report marine species sightings to augment scientific data collection and to further verify the implementation of mitigation measures is unnecessary and would increase safety risks to personnel, be impractical with regard to implementation of military readiness activities, and result in unacceptable impact on readiness for the reasons below.

Vessels, aircraft, and personnel engaged in training and testing events are intensively employed throughout the duration of training and testing activities. Any additional workload assigned that is unrelated to their primary duty would adversely impact personnel safety and the effectiveness of the military readiness activity they are undertaking. Lookouts are not trained to make accurate species-specific identification and would not be able to provide the detailed information that the scientific community would use. Alternatively, the Navy has an integrated comprehensive monitoring program (Section 5.5, Monitoring and Reporting) that does provide information that is available and useful to the scientific community in annual monitoring reports.

5.3.4.2 Previously Accepted but Now Eliminated

5.3.4.2.1 Implementing Active Sonar Ramp-Up Procedures During Testing

Some testing activities have implemented active sonar ramp-up procedures (slowly increasing the sound in the water to necessary levels) in an attempt to clear the range prior to conduct of activities for the purpose of mitigation. Although ramp-up procedures have been used for some testing activities, the effectiveness at avoiding or reducing impacts on marine mammals has not been demonstrated. Until evidence suggests that ramp-procedures are an effective means of avoiding or reducing potential impacts on marine mammals, and for reasons discussed in section 5.3.4.1.4 (Implementing Active Sonar Ramp-Up Procedures During Training), the Navy is proposing to eliminate the implementation of this measure for testing activities as part of the Proposed Action.

5.3.4.2.2 Implementing a Mitigation Zone for Missile Exercises with Airborne Targets

Per current mitigation, a mitigation zone of 1,000 yd. (914 m) is observed around the expected expended material field. The Navy is proposing to eliminate the need for a Lookout to maintain a mitigation zone for missile exercises involving airborne targets. Most airborne targets are recoverable aerial drones, and missile impact with the target does not typically occur. Most anti-air missiles used in training are telemetry configured (i.e., they do not have an actual warhead). Impact of a target is unlikely because missiles are designed to detonate (simulated detonation for telemetry missiles) in the vicinity of the target and not as a result of a direct strike on the target. Given the speed of the missile and the target, the high altitudes involved, and the long ranges of missile travel possible, it is not possible to definitively predict or to effectively observe where the missile fragments will fall. The potential expended material fall zone can only be predicted within tens of miles for long range events, which can be in excess of 80 nm from the firing location, and thousands of yards for shorter events, which can occur within several thousand yards from the firing location. Establishment of a mitigation zone for activities involving airborne targets would be ineffective at reducing potential impacts.

Furthermore the potential risk to any marine mammal or sea turtle from a missile exercise with an airborne target is a direct strike from falling expended material. Based on the extremely low potential for a target strike and associated expended material field to co-occur in space and time with a marine species at or near the surface of the water, the potential for a direct strike is negligible.

5.3.4.2.3 Implementing a Mitigation Zone for Medium- and Large-Caliber Gunnery Exercises with Airborne Targets

Per current mitigation, a mitigation zone is observed in the vicinity of the expected military expended materials field. The Navy is proposing to eliminate the need for a Lookout to observe the vicinity of the expected military expended materials for medium- and large-caliber gunnery exercises involving airborne targets. The potential military expended materials fall zone can only be predicted within thousands of yards, which can be up to 7 nm from the firing location. Establishment of a mitigation zone for activities involving airborne targets would be ineffective at reducing potential impacts.

Furthermore, the potential risk to any marine mammal or sea turtle from a gunnery exercise with an airborne target is a direct strike from falling military expended materials. Based on the extremely low potential for military expended materials to co-occur in space and time with a marine species at or near the surface of the water, the potential for a direct strike is negligible.

5.3.4.2.4 Implementing Measures for Laser Test Operations

Visual surveys would be conducted for all testing activities involving laser line scan, light imaging detection, and ranging lasers. Per Navy standard operating procedures, only trained personnel operate lasers and visual observation of the area is conducted to ensure human safety. The Navy is proposing to discontinue this procedure as a mitigation measure because: (1) it is currently a standard operating procedure conducted for human safety, and (2) the environmental consequences analysis suggests that impacts on resources from laser activities are not expected.

5.4 Mitigation Summary

Table 5.4-1 provides a summary of the Navy's recommended mitigation measures. For reference, currently implemented mitigation measures for each activity category are also summarized in the table. The process for developing each of these measures is detailed in Section 5.2.3 (Assessment Method) and involved: (1) an effectiveness assessment to determine if implementation of the measure will likely result in avoidance or reduction of an impact on a resource; and (2) an operational assessment to determine if implementation of the measures will have acceptable operational impacts on the Proposed Action with regard to personnel safety, practicability of implementation, readiness, and Navy policy. Measures are intended to meet applicable regulatory compliance requirements for NEPA, Executive Order 12114, and Council on Environmental Quality guidance. The Navy recommended mitigation measures were also developed consistent with resource-specific environmental requirements, as follows:

- Measures specifying marine mammals and indicators of marine mammal presence (large schools of fish or flocks of seabirds) as the protection focus are intended to meet MMPA requirements.
- Measures specifying marine mammals, sea turtles, flocks of seabirds, large schools of fish, jellyfish aggregations, or shallow coral reefs as the protection focus are intended to meet ESA requirements.
- Measures specifying shallow coral reefs, live hardbottom, artificial reefs, or shipwrecks as the protection focus are intended to meet Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act.
- Measures specifying shipwrecks is an additional protection focus intended to meet Abandoned Shipwreck Act and National Historic Preservation Act requirements.

The measures presented in Table 5.4-1 are discussed in greater detail in Section 5.3.1 (Lookout Procedural Measures), Section 5.3.2 (Mitigation Zone Procedural Measures), and Section 5.3.3 (Mitigation Areas). As discussed in Section 5.2.2.2 (Protective Measures Assessment Protocol), the final suite of mitigations resulting from the ongoing planning for this EIS/OEIS, as well as the regulatory consultation and permitting processes, will be integrated into the Protective Measures Assessment Protocol for implementation purposes. Section 5.5 (Monitoring and Reporting) describes the monitoring and reporting efforts the Navy will undertake to investigate the effectiveness of implemented mitigation measures and to better understand the impacts of the Proposed Action on marine resources.

Table 5.4-1: Summary of Recommended Mitigation Measures

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Specialized Training	Lookouts will complete the Introduction to the U.S. Navy Afloat Environmental Compliance Training Series and the U.S. Navy Marine Species Awareness Training.	The mitigation zones observed by Lookouts are specified for each Mitigation Zone Procedural Measure below.	Applicable personnel will complete the U.S. Navy Marine Species Awareness Training prior to standing watch or serving as a Lookout.
Low-Frequency and Hull-Mounted Mid-Frequency Active Sonar during Anti-Submarine Warfare and Mine Warfare	2 Lookouts (general) 1 Lookout (minimally manned, moored, or anchored)	Sources that can be powered down: 1,000 yd. (914 m) and 500 yd. (457 m) power downs and 200 yd. (183 m) shutdown for marine mammals (hull-mounted mid-frequency and low-frequency) and sea turtles (low-frequency only). Sources that cannot be powered down: 200 yd. (183 m) shutdown for marine mammals and sea turtles.	Hull-mounted mid-frequency: 1,000 yd. (914 m) and 500 yd. (457 m) power downs and 200 yd. (183 m) shutdown for marine mammals and sea turtles Low-frequency: None
High-Frequency and Non-Hull Mounted Mid-Frequency Active Sonar	1 Lookout	200 yd. (183 m) for marine mammals (high-frequency and mid-frequency), sea turtles (bins MF8, MF9, MF10, and MF12 only)	Non-hull mounted mid-frequency: 200 yd. (183 m) for marine mammals High-frequency: None
Improved Extended Echo Ranging Sonobuoys	1 Lookout	600 yd. (549 m) for marine mammals and sea turtles Passive acoustic monitoring conducted with Navy assets participating in the activity.	1,000 yd. (914 m) for marine mammals and sea turtles Passive acoustic monitoring conducted with Navy assets participating in the activity.
Explosive Sonobuoys using 0.6–2.5 lb. NEW	1 Lookout	350 yd. (320 m) for marine mammals and sea turtles Passive acoustic monitoring conducted with Navy assets participating in the activity.	None
Anti-Swimmer Grenades	1 Lookout	200 yd. (183 m) for marine mammals and sea turtles	None.

Notes: NEW = net explosive weight, yd. = yard, m = meters

Table 5.4-1: Summary of Recommended Mitigation Measures (continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Mine Countermeasures and Mine Neutralization using Positive Control Firing Devices	General: 1 or 2 Lookouts (NEW dependent) Diver-placed: 2 Lookouts Lookouts will survey the mitigation zone for seabirds prior to and after the detonation event.	NEW dependent for marine mammals and sea turtles	None
Mine Neutralization Activities Using Diver-Placed Time-Delay Firing Devices	4 Lookouts Lookouts will survey the mitigation zone for seabirds prior to and after the detonation event.	Up to 10-minute time-delay using up to 29 lb. NEW: 1,000 yd. (915 m) for marine mammals and sea turtles.	10-minute time-delay on up to 10 lb. NEW: 1,500 yd. (1,372 m) for marine mammals and sea turtles
Explosive and Non-Explosive Gunnery Exercises – Small- and Medium-Caliber Using a Surface Target	1 Lookout	200 yd. (183 m) for marine mammals and sea turtles	None

Notes: ft. = feet, km = kilometers, lb. = pounds, m = meters, mi.=miles, NEW = net explosive weight, nm = nautical miles, yd. = yards

Table 5.4-1: Summary of Recommended Mitigation Measures (continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Explosive and Non-Explosive Gunnery Exercises – Large-Caliber Using a Surface Target	1 Lookout	Explosive: 600 yd. (549 m) for marine mammals and sea turtles Non-Explosive: 200 yd. (183 m) for marine mammals and sea turtles Both: 70 yd. (64 m) within 30 degrees on either side of the gun target line on the firing side for marine mammals and sea turtles Both: 350 yd. (320 m) for surveyed shallow coral reefs	Explosive: 600 yd. (549 m) for marine mammals, sea turtles and surveyed shallow coral reefs Non-Explosive: 200 yd. (183 m) for marine mammals and sea turtles. Both: 70 yd. (64 m) around entire ship for marine mammals and sea turtles.
Non-Explosive Missile Exercises and Explosive Missile Exercises (Including Rockets) up to 250 lb. NEW using a Surface Target	1 Lookout	900 yd. (823 m) for marine mammals and sea turtles 350 yd. (320 m) for surveyed shallow coral reefs	1,800 yd. (1.7 km) for marine mammals, sea turtles
Explosive Missile Exercises (Including Rockets) from 251 to 500 lb. NEW using a Surface Target	1 Lookout	2,000 yd. (1.8 km) for marine mammals and sea turtles 350 yd. (320 m) for surveyed shallow coral reefs	None
Bombing Exercises, Explosive and Non-Explosive	1 Lookout	Explosive: 2,500 yd. (2.3 km) for marine mammals and sea turtles Non-Explosive: 1,000 yd. (914 m) for marine mammals and sea turtles Both: 350 yd. (320 m) for surveyed shallow coral reefs	Explosive: 1,000 yd. (914 m) for marine mammals, sea turtles Non-Explosive: 1,000 yd. (914 m) for marine mammals, sea turtles

Notes: ft. = feet, km = kilometers, lb. = pounds, m = meters, NEW = net explosive weight, yd. = yards

Table 5.4-1: Summary of Recommended Mitigation Measures (continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Torpedo (Explosive) Testing	1 Lookout	2,100 yd. (1.9 km) for marine mammals and sea turtles and jellyfish aggregations Passive acoustic monitoring conducted with Navy assets participating in the activity.	None
Sinking Exercises	2 Lookouts	2.5 nm for marine mammals and sea turtles and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.	2.0 nm for marine mammals, sea turtles, and jellyfish aggregations
Vessel Movements	1 Lookout	500 yd. (457 m) for whales 200 yd. (183 m) for all other marine mammals (except bow riding dolphins)	500 yd. (457 m) for whales 200 yd. (183 m) for all other marine mammals (except bow riding dolphins)
Towed In-Water Device Use	1 Lookout	250 yd. (229 m) for marine mammals	250 yd. (229 m) for marine mammals
Precision Anchoring	No Lookouts in addition to standard personnel standing watch	Avoidance of precision anchoring within the anchor swing diameter of shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks	None
Shallow Coral Reefs, Hardbottom Habitat, Artificial Reefs, and Shipwrecks	No Lookouts in addition to standard personnel standing watch	The Navy will not conduct precision anchoring within the anchor swing diameter, or explosive mine countermeasure and neutralization activities (except in existing anchorages and near-shore training areas around Guam and within Apra Harbor) within 350 yd. (320 m) of surveyed shallow coral reefs, live hardbottom, artificial reefs, and shipwrecks. No explosive or non-explosive small-, medium-, and large-caliber gunnery exercises using a surface target, explosive or non-explosive missile exercises using a surface target, explosive and non-explosive bombing exercises, or at-sea explosive testing within 350 yd. (320 m) of surveyed shallow coral reefs	Varying mitigation zone distances based on marine mammal ranges to effects

Notes: km = kilometers, lb. =pounds, m = meter, nm = nautical miles, yd. = yards

5.5 MONITORING AND REPORTING

5.5.1 APPROACH TO MONITORING

The Navy is committed to demonstrating environmental stewardship while executing its National Defense Mission and complying with the suite of Federal environmental laws and regulations. As a complement to the Navy's commitment to avoiding and reducing impacts of the Proposed Action through mitigation, the Navy will undertake monitoring efforts to track compliance with take authorizations, help evaluate the effectiveness of implemented mitigation measures, and gain a better understanding of the effects of the Proposed Action on marine resources. Taken together, mitigation and monitoring comprise the Navy's integrated approach for reducing environmental impacts from the Proposed Action. The Navy's overall monitoring approach will seek to leverage and build on existing research efforts whenever possible.

Consistent with the cooperating agency agreement with NMFS, mitigation and monitoring measures presented in this EIS/OEIS focus on the requirements for protection and management of marine resources. A well-designed monitoring program can provide important feedback for validating assumptions made in analyses and allow for adaptive management of marine resources. Since monitoring will be required for compliance with the final rule issued for the Proposed Action under the MMPA, details of the monitoring program will be developed in coordination with NMFS through the regulatory process. Discussions with resource agencies during the consultation and permitting processes may result in changes to the mitigation as described in this document. Such changes will be reflected in the Final EIS/OEIS, Record of Decision, and consultation documents such as the ESA Biological Opinion.

5.5.1.1 Integrated Comprehensive Monitoring Program

The Integrated Comprehensive Monitoring Program is intended to coordinate monitoring efforts across all regions where the Navy trains and tests and to allocate the most appropriate level and type of effort for each range complex (U.S. Department of the Navy 2010). The current Navy monitoring program is composed of a collection of "range-specific" monitoring plans, each of which was developed individually as part of MMPA and ESA compliance processes as environmental documentation was completed. These individual plans establish specific monitoring requirements for each range complex or testing range and are collectively intended to address the Integrated Comprehensive Monitoring Plan top-level goals.

A 2010 Navy-sponsored monitoring meeting in Arlington, Virginia, initiated a process to critically evaluate the current Navy monitoring plans and begin development of revisions and updates to both existing region-specific plans as well as the Integrated Comprehensive Monitoring Plan. Discussions at that meeting as well as the following Navy and NMFS annual adaptive management meeting established a way ahead for continued refinement of the Navy's monitoring program. This process included establishing a Scientific Advisory Group of leading marine mammal scientists with the initial task of developing recommendations that would serve as the basis for a Strategic Plan for Navy monitoring. The Strategic Plan is intended to be a primary component of the Integrated Comprehensive Monitoring Program, and provide a "vision" for Navy monitoring across geographic regions, and serve as guidance for determining how to most efficiently and effectively invest the marine species monitoring resources to address Integrated Comprehensive Monitoring Plan top-level goals and satisfy MMPA Letter of Authorization regulatory requirements.

The objective of the Strategic Plan is to continue the evolution of Navy marine species monitoring towards a single integrated program, incorporating Scientific Advisory Group recommendations, and establishing a more transparent framework for soliciting, evaluating, and implementing monitoring work across the range complexes and testing ranges. The Strategic Plan must consider a range of factors in addition to the scientific recommendations including logistic, operational, and funding considerations and will be revised regularly as part of the annual adaptive management process.

The Integrated Comprehensive Monitoring Plan establishes top-level goals that have been developed in coordination with NMFS (U.S. Department of the Navy 2010). The following top-level goals will become more specific with regard to identifying potential projects and monitoring field work through the Strategic Plan process as projects are evaluated and initiated in the MITT Study Area.

- An increase in the understanding of the likely occurrence of marine mammals or ESA-listed marine species in the vicinity of the action (i.e., presence, abundance, distribution, and density of species);
- An increase in the understanding of the nature, scope, or context of the likely exposure of marine mammals and ESA-listed species to any of the potential stressor(s) associated with the action (e.g., tonal and impulse sound), through better understanding of one or more of the following: (1) the action and the environment in which it occurs (e.g., sound source characterization, propagation, and ambient noise levels), (2) the affected species (e.g., life history or dive patterns), (3) the likely co-occurrence of marine mammals and ESA-listed marine species with the action (in whole or part) associated with specific adverse impacts, or (4) the likely biological or behavioral context of exposure to the stressor for the marine mammal and ESA-listed marine species (e.g., age class of exposed animals or known pupping, calving or feeding areas);
- An increase in the understanding of how individual marine mammals or ESA-listed marine species respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, e.g., at what distance or received level);
- An increase in the understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: (1) the long-term fitness and survival of an individual; or (2) the population, species, or stock (e.g., through impacts on annual rates of recruitment or survival);
- An increase in the understanding of the effectiveness of mitigation and monitoring measures;
- A better understanding and record of the manner in which the authorized entity complies with the Incidental Take Authorization and Incidental Take Statement;
- An increase in the probability of detecting marine mammals (through improved technology or methods), both specifically within the mitigation zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals; and
- A reduction in the adverse impact of activities to the least practicable level, as defined in the MMPA.

5.5.1.2 Scientific Advisory Group Recommendations

Navy established the Scientific Advisory Group in 2011 with the initial task of evaluating current Navy monitoring approaches under the Integrated Comprehensive Monitoring Plan and existing MMPA Letters of Authorization and developing objective scientific recommendations that would form the basis for the Strategic Plan. While recommendations were fairly broad and not prescriptive from a range complex perspective, the Scientific Advisory Group did provide specific programmatic recommendations that serve as guiding principles for the continued evolution of the Navy Marine Species Monitoring Program and provide a direction for the Strategic Plan to move this development. Key recommendations include:

- Working within a conceptual framework of knowledge, from basic information on the occurrence of species within each range complex, to more specific matters of exposure, response, and consequences.
- Facilitating collaboration among researchers in each region, with the intent to develop a coherent and synergistic regional monitoring and research effort.
- Striving to move away from a "box-checking" mentality. Monitoring studies should be designed and conducted according to scientific objectives, rather than on merely cataloging effort expended.
- Approach the monitoring program holistically and select projects that offer the best opportunity to advance understanding of the issues, as opposed to establishing range-specific requirements.

5.5.2 Reporting

The Navy is committed to documenting and reporting relevant aspects of training and testing activities in to verify implementation of mitigation, comply with current permits, and improve future environmental assessments. Navy reporting initiatives are described below.

5.5.2.1 Exercise and Monitoring Reporting

The Navy will submit annual exercise and monitoring reports to the Office of Protected Resources at NMFS. The exercise reports will describe the level of training and testing conducted during the reporting period, and the monitoring reports will describe both the nature of the monitoring that has been conducted and the actual results of the monitoring. All of the details regarding the content of the annual reports will be coordinated with NMFS through the permitting process. All reports submitted to date can be found on the NMFS Office of Protected Resources webpage.

5.5.2.2 Stranding Response Plan

In coordination with NMFS, the Navy will have a stranding response plan. All of the details regarding the content of the stranding response plan will be coordinated with NMFS through the permitting process.

5.5.2.3 Bird Strike Reporting

The Navy will report all damaging and non-damaging bird strikes to the Naval Safety Center.

5.5.2.4 Marine Mammal Incident Reporting

If any injury or death of a marine mammal is observed during training or testing activities, the Navy will immediately halt the activity and report the incident, including dead for injured animals, to NMFS or the United States Fish and Wildlife Service, as appropriate.

5.6 Terrestrial Resources

Conservation measures described in the 2010 MIRC Biological Opinion are implemented to minimize, avoid, or offset impacts associated with training activities. The current MIRC BO will expire on 1 August 2015. Mitigation and conservation measures on land are being coordinated through the Section 7 Endangered Species Act consultation process between the Navy and the USFWS. These measures will be included in the FEIS with the publication of the USFWS Biological Opinion.

5.7 Cultural Resources

Based on consultations with the Guam State Historic Preservation Officer, CNMI Historic Preservation Officer, Advisory Council on Historic Preservation, and the National Park Service, a Programmatic

Agreement was negotiated in 2009 for all military training activities proposed under the MIRC EIS/OEIS Preferred Alternative and included additional mitigation measures and procedures. Mitigation measures and procedures included in the 2009 Programmatic Agreement will be implemented to avoid and minimize impacts on cultural resources from training activities.

REFERENCES

Baird, R. W., Webster, D. L., Schorr, G. S., McSweeney, D. J. & Barlow, J. (2008). Diel variation in beaked whale diving behavior. *Marine Mammal Science*, 24(3), 630-642.

Barlow, J., Ferguson, M. C., Perrin, W. F., Ballance, L., Gerrodette, T., Joyce, G. (2006). Abundance and densities of beaked and bottlenose whales (family Ziphiidae). *Journal of Cetacean Research and Management, 7*(3), 263-270.

Barlow, J. & Forney, K. A. (2007). Abundance and population density of cetaceans in the California Current ecosystem. *Fishery Bulletin, 105*, 509-526.

Barlow, J., Ferguson, M. C., Perrin, W. F., Ballance, L., Gerrodette, T., Joyce, G., MacLeod, C. D., Mullin, K., Palka, D. L. & Waring, G. (2006). Abundance and densities of beaked and bottlenose whales (family Ziphiidae). Journal of Cetacean Research and Management, 7(3), 263-270.

Carretta, J. V., Lowry, M. S., Stinchcomb, C. E., Lynne, M. S. & Cosgrove, R. E. (2000). Distribution and abundance of marine mammals at San Clemente Island and surrounding offshore waters: Results from aerial and ground surveys in 1998 and 1999 [Administrative Report]. (LJ-00-02, pp. 43). La Jolla, CA: NOAA: Southwest Fisheries Science Center.

Hazel, J., Lawler, I. R., Marsh, H. & Robson, S. (2007). Vessel speed increases collision risk for the green turtle Chelonia mydas. *Endangered Species Research, 3*, 105-113.

Jefferson, T. A., Webber, M. A. & Pitman, R. L. (2008). *Marine Mammals of the World: A Comprehensive Guide to their Identification* (pp. 573). London, UK: Elsevier.

Kenney, R. D. (2005). Personal communication via email between Dr. Robert Kenney, University of Rhode Island, and Mr. William Barnhill, Geo-Marine, Inc. W. Barnhill and GeoMarine Inc., Plano, Texas.

MacLeod, C. D. & D'Amico, A. (2006). A review of beaked whale behaviour and ecology in relation to assessing and mitigating impacts of anthropogenic noise. *Journal of Cetacean Research and Management, 7*(3), 211-222.

Mansfield, K. L. (2006). *Sources of Mortality, Movements and Behavior of Sea Turtles in Virginia.* The College of William and Mary.

Marine Species Modeling Team. (2013). Determination of Acoustic Effects on Marine Mammals and Sea Turtles for the Mariana Islands Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement. Newport, Rhode Island: Naval Undersea Warfare Center Division.

Marsh, H. & Saalfeld, W. K. (1989). Aerial Surveys of Sea Turtles in the Northern Great Barrier Reef Marine Park. Australia Wildlife Research, 16, 239-249.

Tyack, P. L., M. Johnson, N. Aguilar Soto, A. Sturlese and P. T. Madsen. (2006). Extreme deep diving of beaked whales. Journal of Experimental Biology 209: 4238-4253.

U.S. Department of the Navy. (2010). Navy Integrated Comprehensive Monitoring Plan. [Final Report 2010]. 73.

This Page Intentionally Left Blank

6 Additional Regulatory Considerations

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

This Page Intentionally Left Blank

6 ADDITIONAL REGULATORY CONSIDERATIONS

In accordance with the Council on Environmental Quality regulations for implementing the National Environmental Policy Act (NEPA), federal agencies shall, to the fullest extent possible, integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively. This chapter summarizes environmental compliance for the Proposed Action, consistency with other federal, state, and local plans, policies, and regulations not considered in Chapter 3 (Affected Environment and Environmental Consequences); the relationship between short-term impacts; and the maintenance and enhancement of long-term productivity in the affected environment; irreversible and irretrievable commitments of resources, and energy conservation.

6.1 CONSISTENCY WITH OTHER APPLICABLE FEDERAL, STATE, AND LOCAL PLANS, POLICIES, AND REGULATIONS

Implementation of the Proposed Action for the Mariana Islands Training and Testing (MITT) Environmental Impact Statement (EIS)/Overseas EIS (OEIS) would comply with applicable federal, state, and local laws, regulations, and executive orders. The Navy is consulting with and will continue to consult with regulatory agencies, as appropriate, during the NEPA process and prior to implementation of the Proposed Action to ensure that requirements are met. Table 6.1-1 summarizes environmental compliance requirements not considered in Chapter 3 (Affected Environment and Environmental Consequences) that were considered in preparing this EIS/OEIS (including those that may be secondary considerations in the resource evaluations). Section 3.0.1 (Regulatory Framework) provides brief excerpts of the primary federal statutes, executive orders, international standards, and guidance that form the regulatory framework for the resource evaluations. Documentation of consultation and coordination with regulatory agencies is provided in Appendix C (Agency Correspondence). Formal Endangered Species Act consultation will start following the Draft EIS release. Not all consultation documentation is included in Appendix C (Agency Correspondence) or on the website at this time, but all compliance will be completed prior to the signing of the Record of Decision for the Proposed Action.

Table 6.1-1: Summary of Environmental Compliance for the Proposed Action

Laws, Executive Orders, International Standards, and Guidance	Status of Compliance
Laws	
Abandoned Shipwreck Act (43 U.S.C. §§2101–2106)	The 1987 Abandoned Shipwreck Act establishes requirements for educational and recreational access to abandoned shipwrecks; the protection of such resources through the establishment of underwater parks and protected areas; the development of specific guidelines for management and protection in consultation with various stakeholders; defines the jurisdiction and responsibility of federal and state agencies; and explicitly states that the law of salvage and the law of finds do not apply. Under the Act, the Department of the Interior and National Park Service issued guidelines in 2007 to help states manage shipwrecks in their waters. The Act defines the federal government's title to any abandoned shipwreck that meets criteria for inclusion in the National Register of Historic Places within state submerged lands, with the stipulation that title to these shipwrecks will be transferred to the appropriate state. For abandoned shipwrecks in U.S. Territorial Waters, the federal government asserts title to the resource, the federal government then transfers title to the state, territory, or commonwealth whose submerged lands contain the shipwreck. See Section 3.11 (Cultural Resources), for assessment and conclusion that the Proposed Action is consistent with the Act.
Act to Prevent Pollution from Ships (33 U.S.C. §1901 et seq.)	Requirements associated with the Act to Prevent Pollution from Ships are implemented by the Navy Environmental and Natural Resources Program Manual and related Navy guidance documents governing waste management, pollution prevention, and recycling. At sea, the Navy complies with these regulations and operates in a manner that minimizes or eliminates any adverse effects to the marine environment.
Antiquities Act (16 U.S.C. §431)	The Proposed Action is consistent with the Act's objectives for protection of archaeological and historical sites and objects, preservation of cultural resources, and the public's access to them.
Coastal Zone Management Act (16 C.F.R. §1451 et seq.)	The Navy will continue compliance with the Coastal Zone Management Act. See Section 6.1.1 (Coastal Zone Management Act Compliance) below, for discussion of Navy activities and compliance with the Coastal Zone Management Act.
Historic Sites Act (16 U.S.C. §§461–467)	The Proposed Action is consistent with the national policy for the preservation of historic sites, buildings, and objects of national significance.
National Fishery Enhancement Act (33 U.S.C. §2101 et seq.)	The Proposed Action is consistent with regulations administered by National Marine Fisheries Service and U.S. Army Corps of Engineers concerning artificial reefs in the navigable waters of the United States. See Section 3.9 (Fish) for the assessment.
National Marine Sanctuaries Act (16 U.S.C. §1431 et seq.)	There are no National Marine Sanctuary System designated sanctuaries within the MITT Study Area.
Rivers and Harbors Act (33 U.S.C. §401 et seq.)	In accordance with U.S. Army Corps of Engineers regulations, no permit is required under the Rivers and Harbors Act because no construction in navigable waterways is proposed.

Table 6.1-1: Summary of Environmental Compliance for the Proposed Action (continued)

Laws, Executive Orders, International Standards, and Guidance	Status of Compliance
Laws (continued)	
The Sikes Act of 1960 (16 U.S.C. §§670a-670o, as amended by the Sikes Act Improvement Act of 1997, Public Law No. 105-85), requires military installations with significant natural resources to prepare and implement Integrated Natural Resource Management Plans (INRMPs).	The Proposed Action would be implemented in accordance with the management and conservation criteria developed in the Integrated Natural Resources Management Plans (INRMPs) for the Mariana Islands Range Complex. The Proposed Action and Alternatives will not result in a requirement for an update of INRMPs outside of their normal update schedule of every 5 years.
Submerged Lands Act of 1953 (43 U.S.C. §§1301–1315)	The Proposed Action is consistent with regulations concerning the Submerged Lands Act.
Sunken Military Craft Act (Public Law 108-375, 10 U.S.C. §113 Note and 118 Stat. 2094–2098)	The Proposed Action would have no adverse effects on sunken U.S. military ships and aircraft within the Study Area. If a site is determined to be eligible for the National Register of Historic Places, the State Historic Preservation Officer would be consulted to address potential effects. See Section 3.11 (Cultural Resources), for the assessment.
Military Munitions Rule	The Military Munitions Rule identifies when conventional and chemical military munitions are considered solid waste under the Resource Conservation and Recovery Act (42 U.S.C. §6901 et seq.). Military munitions are not considered solid waste based on two conditions stated at 40 C.F.R. §266.202(a)(1)(i-iii). These two conditions are when munitions are used for their intended purpose and when unused munitions or a component of are subject to materials recovery activities. These two conditions cover the uses of munitions included in the Proposed Action; therefore, the Resource Conservation and Recovery Act does not apply.
Executive Orders	
Executive Order 11990*, Protection of Wetlands*	Implementation of the Proposed Action would have no effect on wetlands as defined in Executive Order 11990.
Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*	The Proposed Action would not result in any disproportionately high and adverse human health or environmental effects on minority or low-income populations. See Section 3.0.5.2 (Resources and Issues Eliminated from Further Consideration) for the assessment.
Executive Order 12962*, Recreational Fisheries*	The Proposed Action would have no effect on federal agencies' ability to fulfill certain duties with regard to promoting the health and access of the public to recreational fishing areas. See Section 3.12 (Socioeconomics) for the assessment.
Executive Order 13045*, Protection of Children from Environmental Health Risks and Safety Risks*	The Proposed Action would not result in disproportionate environmental health or safety risks to children. See Section 3.0.5.2 (Resources and Issues Eliminated from Further Consideration) for the assessment.
Executive Order 13089*, Coral Reef Protection*	The Navy has prepared this EIS/OEIS in accordance with requirements for the protection of existing national system marine protected areas. See Section 3.8 (Marine Invertebrates) for the assessment.
Executive Order 13112*, Invasive Species*	The Navy has prepared this EIS/OEIS in accordance with requirements for the prevention of and eradication of invasive species. Naval vessels are exempt from 33 C.F.R. 151 Subpart D, *Ballast Water Management for Control of Non-indigenous Species in Waters of the United States*. See Section 3.10 (Terrestrial Species and Habitats) for the assessment.

Table 6.1-1: Summary of Environmental Compliance for the Proposed Action (continued)

Laws, Executive Orders, International Standards, and Guidance	Status of Compliance
Executive Orders (continued)	
Executive Order 13158, *Marine Protected Areas*	The Navy has prepared this EIS/OEIS in accordance with requirements for the protection of existing national system marine protected areas. See Section 6.1.2 (Marine Protected Areas) for more information.
Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*	The Proposed Action is consistent with the integrated strategy toward sustainability in the federal government and to making reduction of greenhouse gas emissions a priority for federal agencies.
Executive Order 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*	The Proposed Action is consistent with the comprehensive national policy for the *Stewardship of the Ocean, Our Coasts, and the Great Lakes.*
International Standards	
International Convention for the Prevention of Pollution from Ships	This standard prohibits certain discharges of oil, garbage, and other substances from vessels. The convention and its annexes are implemented by national legislation, including the *Act to Prevent Pollution from Ships* (33 U.S.C. §§1901–1915) and the *Federal Water Pollution Control Act* (33 U.S.C. §§1321–1322). The Proposed Action does not include vessel operation and discharge from ships; however, the Navy vessels operating in the Study Area would comply with the discharge requirements established in this program, minimizing or eliminating potential impacts from discharges from ships.

Notes: INRMP = Integrated Natural Resource Management Plan, Navy = United States Department of the Navy, EIS/OEIS = Environmental Impact Statement/Overseas Environmental Impact Statement, U.S.C. = United States Code, U.S. = United States, C.F.R. = Code of Federal Regulations, NMFS = National Marine Fisheries Service, MIRC = Mariana Islands Range Complex

6.1.1 Coastal Zone Management Act Compliance

The *Coastal Zone Management Act of 1972* (16 United States Code [U.S.C.] §1451, et seq.) encourages coastal states and territories to be proactive in managing coastal zone uses and resources. The act established a voluntary coastal planning program under which participating states submit a Coastal Management Plan to the National Oceanic and Atmospheric Administration for approval. Under the act, federal actions that have an effect on a coastal use or resource are required to be consistent, to the maximum extent practicable, with the enforceable policies of federally approved Coastal Management Plans. See Section 4.3.5.3 (Development of Coastal Lands) in the Cumulative Impacts for additional information regarding management of the coastal areas within the MITT Study Area.

The *Coastal Zone Management Act* defines the coastal zone as extending “to the outer limit of State title and ownership under the Submerged Lands Act” (i.e., 3 nautical miles (nm) or 9 nm from the shoreline, depending on the location). The extent of the coastal zone inland varies from state to state and territory to territory, but the shoreward extent is not relevant to this Proposed Action.

A Consistency Determination or a Negative Determination may be submitted for review of federal agency activities. A federal agency submits a consistency determination when it determines that its activity may have either a direct or an indirect effect on a state coastal use or resource. In accordance with 15 Code of Federal Regulations (C.F.R.) §930.39, the consistency determination will include a brief statement indicating whether the proposed activity will be undertaken in a manner consistent to the maximum extent practicable with the enforceable policies of the management program. The consistency determination should be based on evaluation of the relevant enforceable policies of the management program. In accordance with 15 C.F.R. §930.35, "if a Federal agency determines that there will not be coastal effects, then the Federal agency shall provide the State agencies with a negative determination for a Federal agency activity: (1) Identified by a State agency on its list, as described in §930.34(b), or through case-by-case monitoring of unlisted activities; or (2) Which is the same as or is similar to activities for which consistency determinations have been prepared in the past; or (3) For which the Federal agency undertook a thorough consistency assessment and developed initial findings on the coastal effects of the activity." Thus, a negative determination must be submitted to a state if the agency determines no coastal effects and one or more of the criteria above is met.

6.1.1.1 Guam Coastal Management Program

The Guam Coastal Management Program was approved in 1979 and is overseen by the Bureau of Statistics and Plans. It has received 100 percent federal funding through the U.S. Department of Commerce, the National Oceanic and Atmospheric Administration, and annual formula grants since 1979. Guam's Coastal Management Program guides the use, protection, and development of land and ocean resources within Guam's coastal zone and entire land area, due to Guam's small size.

Guam's Coastal Management Program also helps to coordinate and direct a network of government agencies to ensure a balanced approach to coastal management. The greatest issues for the Coastal Management Program have been coral reef and watershed habitat degradation, water quality degradation, coastal hazards, and cultural and historic resource preservation.

6.1.1.2 Commonwealth of the Northern Mariana Islands Coastal Zone Management Program

The Commonwealth of the Northern Mariana Islands Coastal Zone Management Act as established in 1983 and amended in 1990 and 1996, created a voluntary coastal zone enhancement grants program to encourage states and territories in the islands to improve program efforts. The Act brought forth nine coastal zone enhancement areas to be focused on: wetlands, coastal hazards, public access, marine debris, cumulative and secondary impacts, special area management planning, ocean resources, energy and government facility siting, and aquaculture.

Section §309 authorizes the U.S. Secretary of Commerce to make awards to the Commonwealth of the Northern Mariana Islands Coastal Resources Management Office for development and implementation of federally approved program changes in the coastal management programs that help support the one or more of the nine focal enhancement areas. In order to remain eligible for funding, the Coastal Resources Management Office must submit a §309 Assessment and Strategy document every 5 years.

6.1.2 Marine Protected Areas

Many areas of the marine environment have some level of federal, state, or local management or protection. Marine protected areas have conservation or management purposes, defined boundaries, and some legal authority to protect resources. Marine protected areas vary widely in purpose, managing agency, management approaches, level of protection, and restrictions on human uses. They have been designated to achieve objectives ranging from conservation of biodiversity, to preservation of sunken historic vessels, to protection of spawning habitats important to commercial and recreational fisheries. Executive Order (EO) 13158*, Marine Protected Areas,* was created to "strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded marine protected areas; develop a scientifically based, comprehensive national system of marine protected areas representing diverse U.S. marine ecosystems, and the nation's natural and cultural resources; and avoid causing harm to marine protected areas through federally conducted, approved, or funded activities."

Executive Order 13158 requires each federal agency whose actions affect the natural or cultural resources that are protected by a national system of marine protected areas to identify such actions, and in taking such actions, avoid harm to those natural and cultural resources. Pursuant to Section 5 of EO 13158, agency requirements apply only to the natural or cultural resources specifically afforded protection by the site as described by the List of National System Marine Protected Areas. For sites that have both a terrestrial and marine area, only the marine portion and its associated protected resources are included on the List of National System Marine Protected Areas and subject to Section 5 of EO 13158. A full list and map of areas accepted in the National System of Marine Protected Areas is available from the National Marine Protected Areas Center.

The National Marine Protected Areas Center, which is federally managed through the National Oceanic and Atmospheric Administration, is tasked with implementing EO 13158. In order to meet the qualifications for the various terms within EO 13158, the National Marine Protected Areas Center developed a Marine Protected Areas Classification system. This system uses six criteria to describe the key features of most marine protected areas, as follows:

1. Primary conservation focus, such as natural heritage, cultural heritage, or sustainable production
2. Level of protection (e.g., no access, no impact, no take, zoned with no-take areas, zoned multiple use, or uniform multiple use)
3. Permanence of protection
4. Constancy of protection
5. Ecological scale of protection
6. Restrictions on extraction

The National Marine Protected Areas Center utilizes these criteria to evaluate marine protected areas for inclusion in the National System of Marine Protected Areas. Implementation of the National System of Marine Protected Areas is managed by the Department of Commerce and the Department of the Interior. Executive Order 13158 requires the Department of Commerce and the Department of the Interior to consult with other federal agencies about the inclusion of sites into the National System of Marine Protected Areas, including the Department of Defense (DoD). The National System of Marine Protected Areas includes marine protected areas managed under the following six systems:

National Marine Sanctuary System. Under the National Marine Sanctuaries Act, the National Oceanic and Atmospheric Administration established national marine sanctuaries for marine areas with special conservation, recreational, ecological, historical, cultural, archaeological, scientific, educational, or aesthetic qualities. There are no National Marine Sanctuary System designated sanctuaries within the MITT Study Area.

Marine National Monuments. Marine national monuments are designated through Presidential Proclamation under the authority of the Antiquities Act of 1906 (16 U.S.C. 431). Marine national monuments are often co-managed by state, federal, and local governments, in order to preserve diverse habitats and ecosystem functions. Within the MITT Study Area, there is one marine national monument, the Mariana Trench Marine National Monument. In the proclamation designating the Monument, specific language was included that stated: "The prohibitions required by this proclamation shall not apply to activities and exercises of the Armed Forces (including those carried out by the United States Coast Guard)."

National Wildlife Refuge System. The U.S. Fish and Wildlife Service manage ocean and Great Lakes refuges for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats. There are three national wildlife refuge areas within the MITT Study Area, Guam National Wildlife Refuge, Mariana Arc of Fire National Wildlife Refuge, and Mariana Trench National Wildlife Refuge. The Guam National Wildlife Refuge is the only one included in the National System of Marine Protected Areas.

State and Local Marine Protected Areas. State and local governments have established marine protected areas for the management of fisheries, nursery grounds, shellfish beds, recreation, tourism, and other uses; these areas have a diverse array of conservation focuses, from protecting ecological functions, to preserving shipwrecks, to maintaining traditional or cultural interaction with the marine environment. There are 12 state or local marine protected areas (see Table 6.1-2) within the MITT Study Area and they are not included in the National System of Marine Protected Areas.

National Parks System. The National Park System contains ocean and Great Lakes parks, including some national monuments, administered by the U.S. Department of the Interior National Park Service to conserve the scenery and the natural and historic objects and wildlife contained within. The War in the Pacific National Historical Park is within the MITT Study Area, but it is not included in the National System of Marine Protected Areas.

National Estuarine Research Reserve System. National Estuarine Research Reserve System sites protect estuarine land and water and provide essential habitat for wildlife, educational opportunities for students, teachers, the public, and living laboratories for scientists. There are no National Estuarine Research Reserve System sites within the MITT Study Area.

This EIS/OEIS has been prepared in accordance with requirements for natural or cultural resources protected under the National System of Marine Protected Areas. While several marine protected areas are located within the MITT Study Area (see Figure 6.1-1 through Figure 6.1-3) and are included in the National System of Marine Protected Areas, it is important to note that the Navy rarely trains or tests in many of these areas. Navy activities within these marine protected areas abide by the regulations of the individual marine protected area; Table 6.1-2 provides information on the individual marine protected area regulations and the Navy activities that occur in these areas. Figure 6.1-1 shows the Marine Protected Areas in Guam. Figure 6.1-2 shows the Marine Protected Areas in Saipan. Figure 6.1-3 shows the Mariana Trench Marine National Monument.

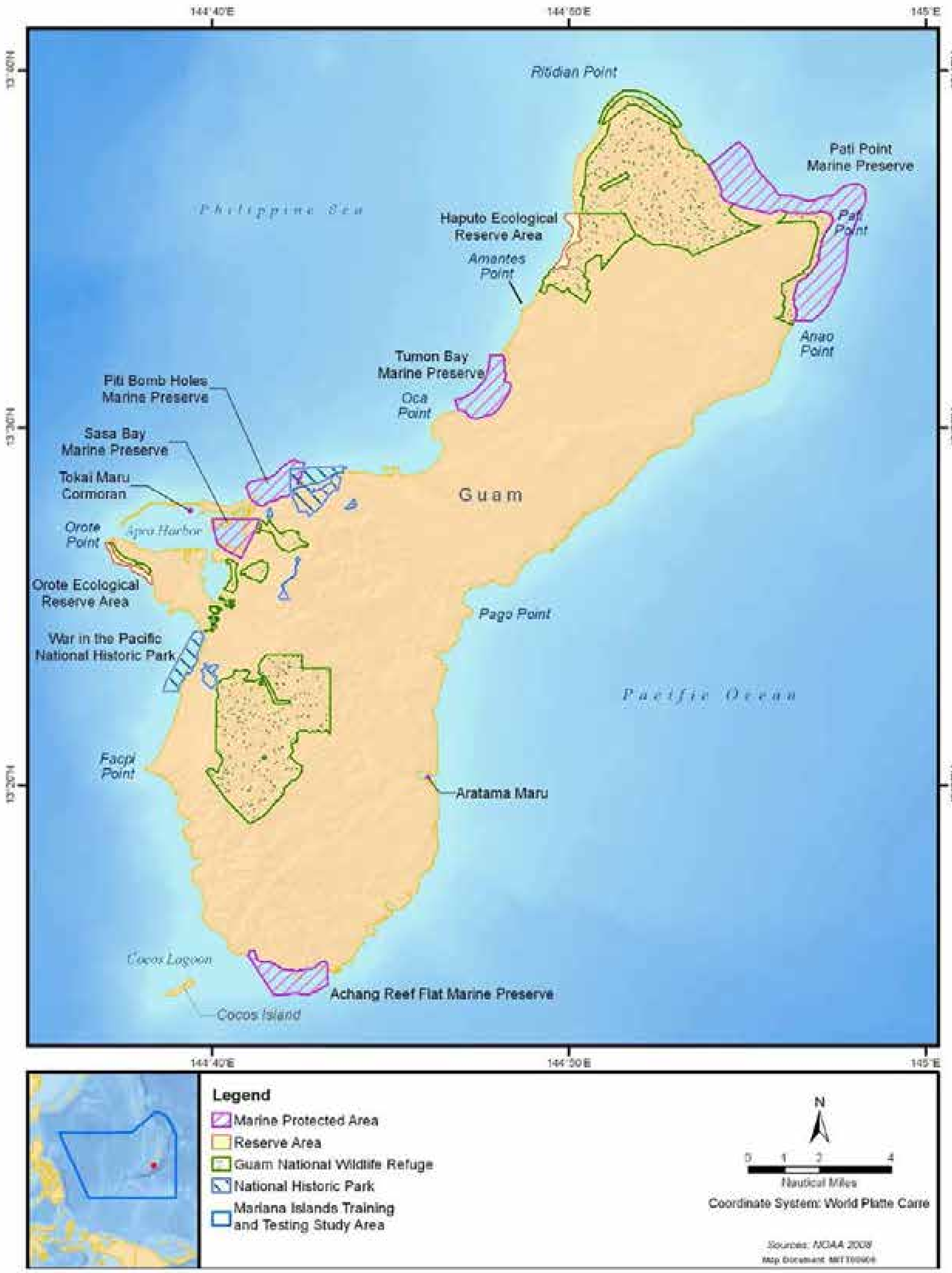


Figure 6.1-1: Marine Protected Areas in Guam

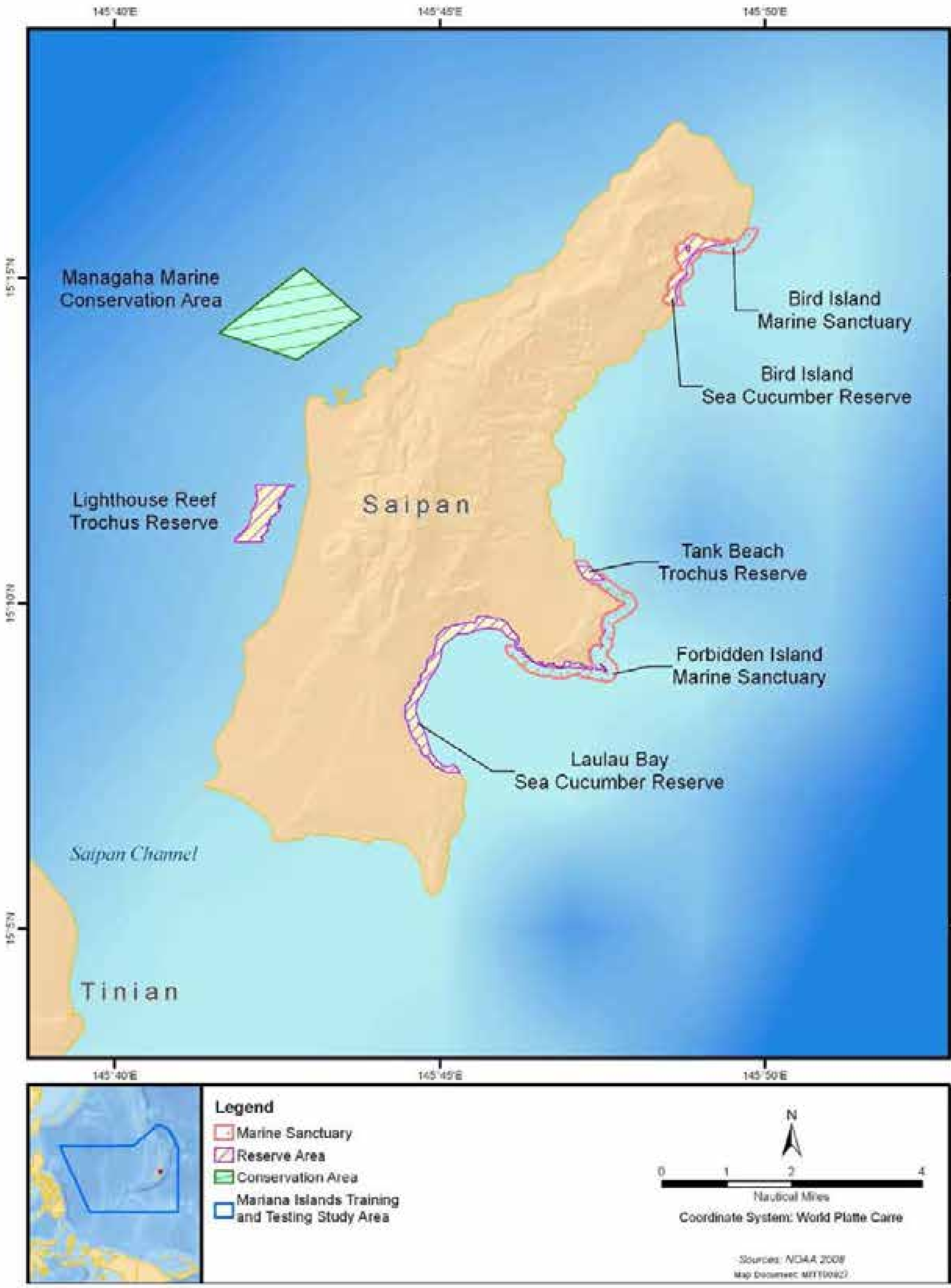


Figure 6.1-2: Marine Protected Areas in Saipan

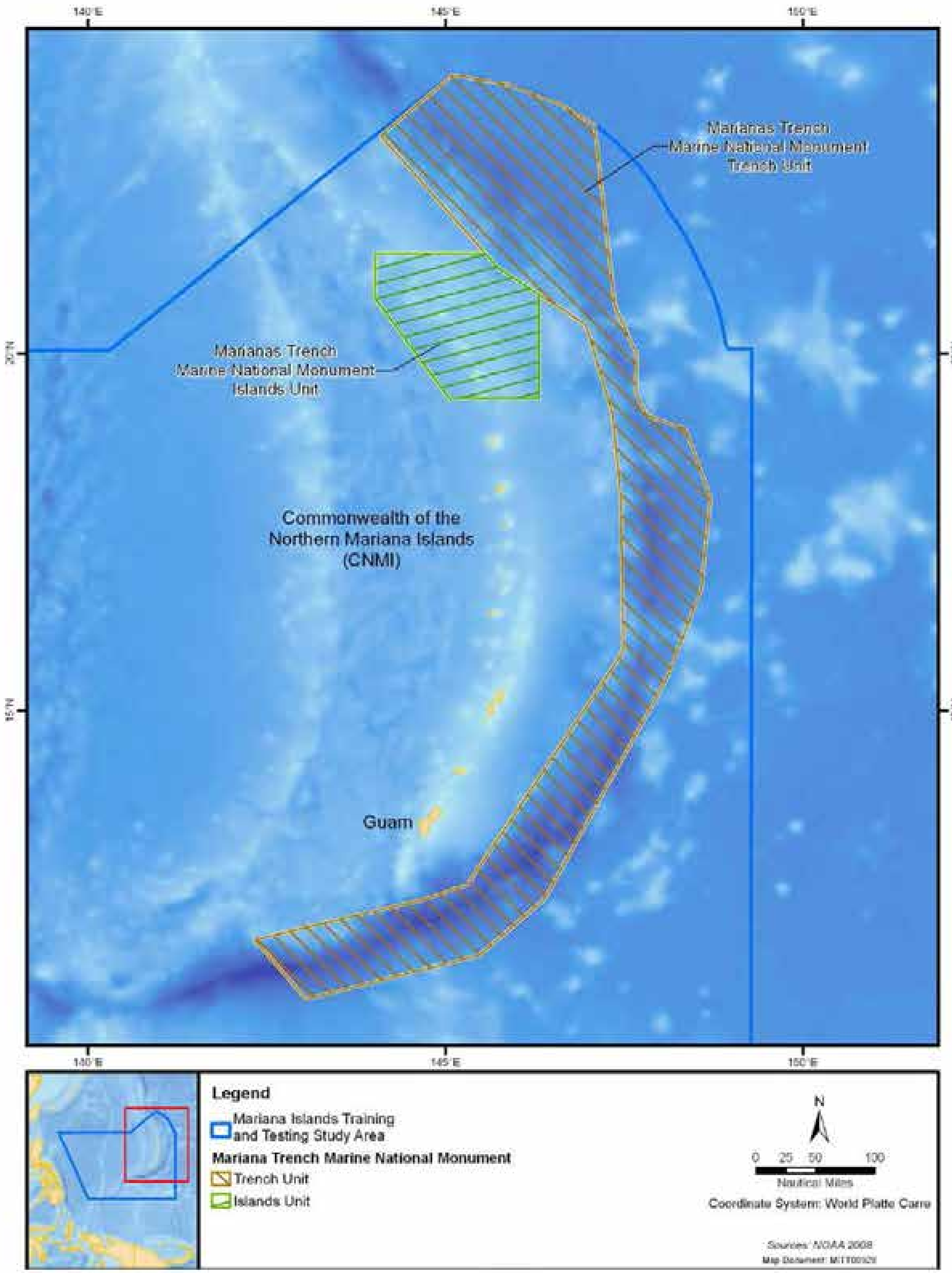


Figure 6.1-3: Mariana Trench Marine National Monument

Table 6.1-2: Marine Protected Areas within the Mariana Islands Training and Testing Study Area

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Guam National Wildlife Refuge	Guam	Ecosystem	Anchoring marine vessels in Refuge waters is strictly prohibited to protect coral Communities.	The Navy does not conduct anchoring or discharge activities in Refuge waters. Amphibious activities and insertion/extraction of personnel via small craft and divers is conducted in or near portions of the Refuge near Orote Point and Haputo Bay, and north Polaris Point Military Welfare and Recreation Beach, and Reserve Craft Beach. The Orote Point Known Distance and Small Arms Ranges danger zone extends over water near the Guam National Wildlife Refuge.
Eligible Marine Protected Areas				
Bird Island Marine Sanctuary	Saipan	Ecosystem	Destruction, harassment and/or removal of plants, and/or wildlife are prohibited within the confines of the sanctuary.	None
Forbidden Island Marine Sanctuary	Saipan	Ecosystem	Destruction, harassment and/or removal of plants, and/or wildlife are prohibited within the confines of the sanctuary.	None
Managaha Marine Conservation Area	Saipan	Ecosystem	Killing, harming, or harassing animals, fish coral or their live or dead parts; dumping, discharging, depositing, and littering on land and in water is prohibited.	None
War in the Pacific National Historical Park	Guam	Ecosystem/ Cultural Resources	U.S. National Park Service regulations apply to this Park area on both land and sea.	None
Not Eligible Marine Protected Areas				
Achang Reef Flat	Guam	Ecosystem	Actions that would negatively impact the reef should not occur in this area.	The Navy is not prohibited from conducting military activity in or near Achang Reef Flat; however, none are specifically proposed to occur there.

Table 6.1-2: Marine Protected Areas within the Mariana Islands Training and Testing Study Area (continued)

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Aratama Maru	Guam	Ecosystem	The prohibitions that apply to this shipwreck do not apply to military activities.	The Navy is not prohibited from conducting military activity in or near Aratama Maru; however, none are specifically proposed to occur there.
Bird Island Sea Cucumber Reserve	Saipan	Focal Resource	No sea cucumbers may be taken from this area except as permitted by the DFW Director.	None
Cormoran	Guam	Ecosystem	The prohibitions that apply to this shipwreck do not apply to military activities.	The Navy conducts Underwater Detonations in Apra Harbor near the Cormoran. This activity is conducted in accordance with JTREGMARIANAS Instruction 3500.4A (Marianas Training Manual) and without impact to the Cormoran.
Haputo Ecological Reserve Area	Guam	Ecosystem	Use of this area is restricted to persons with access to military bases. Ecological reserves are areas selected to preserve representative and special natural ecosystems, plant and animal species, features and phenomena. Scientific research and educational purposes are the principle uses of these reserves, and activities should reflect these goals in this area.	The Navy conducts Navy Special Warfare activities in the Reserve Area. This includes insertion/extraction of personnel by small craft and divers in and near Haputo Bay. Finegayan North Small Arms Range is located near the Reserve and has a surface danger zone that overlays part of the Reserve.
Laulau Bay Sea Cucumber Reserve	Saipan	Focal Resource	Fishing and other living resource extraction are prohibited. Therefore, activities should be restricted in this area based on preserving fish and other resources.	None
Lighthouse Reef Trochus Reserve	Saipan	Focal Resource	Fishing and all other living resource extraction are prohibited. Therefore, activities should be restricted in this area based on preserving fish and other resources.	None

Table 6.1-2: Marine Protected Areas within the Mariana Islands Training and Testing Study Area (continued)

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Mariana Arc of Fire National Wildlife Refuge	Mariana Arc	Ecosystem	This area has been designated to preserve and protect the unique geologic structure and associated marine life at 21 submerged volcanic features within the refuge; maintain the greatest diversity of seamount and hydrothermal vent life yet discovered, provide for the conservation, protection, management, and restoration of fish, wildlife, plants, coral reef communities and other resources associated with the submerged lands; provide opportunities for scientific research and exploration. Any and all activities should be aligned with these goals in this area.	The Navy is not restricted in what training or testing it may conduct within the waters of the Refuge, including sonar-related activities in the vicinity of this area.
Mariana Trench National Wildlife Refuge	Mariana Archipelago/ Mariana Arc	Ecosystem	This area has been designated to preserve and protect the deepest known habitat on the globe; maintain the natural biological diversity there; provide for conservation, protection, management, and restoration of fish, wildlife, plants, and other objects of scientific interest; as well as provide opportunities for national and international refuge related scientific exploration and research. Any and all activities should be aligned with these goals in this area.	The Navy is not restricted in what training or testing it may conduct within the waters above the Refuge, including sonar-related activities in the vicinity of this area.
Mariana Trench Marine National Monument	Mariana Archipelago/ Mariana Arc	Ecosystem	This monument consists of the waters and submerged lands encompassing the coral reef ecosystem of the three northernmost islands, the Mariana trench, and active undersea volcanoes and thermal vents in the Mariana Volcanic arc and back arc. All regulations that apply to these areas apply to the monument; therefore, activities should be in alignment with their goals.	The Navy is not restricted in what training or testing it may conduct within the waters above the Refuge that extends into the MITT Study Area, including sonar-related activities in the vicinity of the Islands unit of the Mariana Trench Marine National Monument. No specific activities are proposed in the Islands unit.

Table 6.1-2: Marine Protected Areas within the Mariana Islands Training and Testing Study Area (continued)

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Orote Ecological Reserve Area	Guam	Ecosystem	Ecological reserves are areas selected to preserve representative and special natural ecosystems, plant and animal species, features and phenomena. Scientific research and educational purposes are the principle uses of these reserves, and activities should reflect these goals in this area.	The Navy does not conduct anchoring discharge activities in Reserve waters. Amphibious activities and insertion/extraction of personnel via small craft and divers are conducted in or near portions of the Refuge near Orote Point. The Orote Point. Known Distance and Small Arms Ranges surface danger zone extends overwater near the Reserve area.
Pati Point	Guam	Ecosystem	Any activities that would negatively impact coral reef habitats and aquatic animals should not occur in this area.	Small arms training is conducted at Air Force Pati Point Combat Arms and Training Maintenance Range. Ordnance is disposed of at the Air Force Pati Point. Explosive Ordnance Disposal range. Both ranges have danger zones which extend over the water into the Pati Point marine area. Navy vessels do not routinely conduct training in this area.
Piti Bomb Holes	Guam	Ecosystem	Any activities that would negatively impact coral reef habitats and aquatic animals should not occur in this area.	The Navy is not prohibited from conducting military activity in or near Piti Bomb Holes; however, no specific activities are proposed to occur there.
Sasa Bay	Guam	Ecosystem	Any activities that would negatively impact coral reef habitats and aquatic animals should not occur in this area.	The Navy is not prohibited from conducting military activity in or near Sasa Bay. The Navy conducts Navy Special Warfare, mine warfare, ordnance demolition training, and amphibious warfare activities in or near Sasa Bay. The Navy does not discharge into Sasa Bay or use explosive ordnance in Sasa Bay.
Sasanhaya Fish Reserve	Rota	Ecosystem	Any activities that would involve taking, fishing, and collecting, anchoring, feeding fish, walking on reef or damaging shipwrecks are prohibited in this area.	None.
Tank Beach Trochus Reserve	Saipan	Focal Resource	Fishing and other living resource extraction are prohibited. Therefore, activities should be restricted in this area based on preserving fish and other resources.	None.

Table 6.1-2: Marine Protected Areas within the Mariana Islands Training and Testing Study Area (continued)

Marine Protected Area	Location Within the Study Area	Protection Focus	Regulations Applicable to Navy Activities	Navy Proposed Activities and Potential Impacts
Tokai Maru	Guam	Ecosystem	The prohibitions that apply to this shipwreck do not apply to military activities.	The Navy conducts Underwater Detonations in Apra Harbor near the Tokai Maru. This activity is conducted in accordance with JTREGMARIANAS Instruction 3500.4A (Marianas Training Manual) and without impact to the Tokai Maru.
Tumon Bay	Guam	Ecosystem	The prohibitions that apply to this preserve do not apply to military activities.	The Navy is not prohibited from conducting military activity in or near Tumon Bay; however, no specific activities are proposed for this area.

Notes: DFW = Division of Fish and Wildlife, Navy = United States Department of the Navy, U.S. = United States

6.2 Relationship Between Short-Term Use of The Environment and Maintenance and Enhancement of Long-Term Productivity

In accordance with the Council on Environmental Quality regulations (Part 1502), this EIS/OEIS analyzes the relationship between the short-term impacts on the environment and the effects those impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This means that choosing one option may reduce future flexibility in pursuing other options, or that committing a resource to a certain use may often eliminate the possibility for other uses of that resource. The Navy, in partnership with National Marine Fisheries Service (NMFS), is committed to furthering the understanding of marine resources and developing ways to lessen or eliminate the impacts Navy training and testing activities may have on these resources. For example, the Navy and NMFS collaborate on the Integrated Comprehensive Monitoring Program for marine species to assess the impacts of training activities on marine species and investigate population-level trends in marine species distribution, abundance, and habitat use in various range complexes and geographic locations where Navy training and testing occurs.

The Proposed Action could result in both short- and long-term environmental impacts. However, these are not expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety, or general welfare of the public. The Navy is committed to sustainable military range management, including co-use of the Study Area with the general public and commercial and recreational interests. This commitment to co-use of the Study Area will maintain long-term accessibility of the MITT EIS/OEIS training and testing areas. Sustainable range management practices are specified in range complex management plans under the Navy's Tactical Training Theater Assessment and Planning Program. Among other benefits, these practices protect and conserve natural and cultural resources and preserve access to training areas for current and future training requirements while addressing potential encroachments that threaten to impact range and training area capabilities.

6.3 Irreversible or Irretrievable Commitment of Resources

The National Environmental Policy Act requires that environmental analysis include identification of "any irreversible and irretrievable commitments of resources which would be involved in the Proposed Action should it be implemented" (42 U.S.C. §4332). Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that the uses of these resources have on future generations. Irreversible effects primarily result from the use or destruction of a specific resource (e.g., energy or minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action (e.g., the disturbance of a cultural site).

For the Proposed Action, most resource commitments would be neither irreversible nor irretrievable. Most impacts would be short term and temporary, or long lasting but within historical or desired conditions. Because there would be no building or facility construction, the consumption of material typically associated with such construction (e.g., concrete, metal, sand, fuel) would not occur. Energy typically associated with construction activities would not be expended and irretrievably lost.

Implementation of the Proposed Action would require fuels used by aircraft and vessels. Since fixed- and rotary-wing aircraft and ship activities could increase relative to the baseline, total fuel use would increase. Therefore, total fuel consumption would increase under the Proposed Action (see Section 6.4, Energy Requirements and Conservation Potential of Alternatives and Mitigation Measures), and this nonrenewable resource would be considered irretrievably lost (see Chapter 4, Cumulative Impacts, and the following discussion on the Navy's Climate Change Roadmap).

6.4 Energy Requirements and Conservation Potential of Alternatives and Mitigation Measures

The federal government consumes 2 percent of the total U.S. energy share (Jean 2010). Of that 2 percent, the DoD consumes 93 percent. The Navy consumes one quarter of the total DoD share. The Navy consumes 1.2 billion to 1.6 billion gallons of fuel each year. The Navy expects a 25 percent increase in fuel consumption in the future because of new ships coming into the fleet and the growth in mission areas (Jean 2010).

Increased training and testing activities within the Study Area would result in an increase in energy demand over the No Action Alternative. The increased energy demand would arise from an increase in fuel consumption, mainly from aircraft and vessels participating in training and testing. Details of fuel consumption by training and testing activities on an annual basis are set forth in the air quality emissions calculation spreadsheets available on the project website. Vessel fuel consumption is estimated to increase by 1.06 million gallons per year under Alternative 1 and 1.3 million gallons per year under Alternative 2, when compared to the No Action Alternative. Aircraft fuel consumption is estimated to increase by 14.8 million gallons per year under Alternative 1 and 17.2 million gallons per year under Alternative 2, respectively, when compared to the No Action Alternative. Vehicle fuel consumption is estimated to increase by 70,647 gallons per year under either Alternative 1 or Alternative 2 when compared to the No Action Alternative. Conservative assumptions were made in developing the estimates, and therefore the actual amount of fuel consumed during training and testing activities may be less than estimated. Nevertheless, the demand for fuel consumption would increase from baseline levels, given the proposed increases in training and testing activities.

Energy requirements would be subject to any established energy conservation practices. The use of energy sources has been minimized wherever possible without compromising safety, training, or testing activities. No additional conservation measures related to direct energy consumption by the proposed activities are identified.

The Navy is committed to improving energy security and environmental stewardship by reducing its reliance on fossil fuels. The Navy is actively developing and participating in energy, environmental, and climate change initiatives that will increase use of alternative energy and help conserve the world's resources for future generations. The Navy Climate Change Roadmap identifies actions the Environmental Readiness Division is taking to implement EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*. The Navy's Task Force Energy is responding to the Secretary of the Navy's Energy Goals through energy security initiatives that reduce the Navy's carbon footprint.

Two Navy programs—the Incentivized Energy Conservation Program and the Naval Sea Systems Command's Fleet Readiness, Research and Development Program—are helping the fleet conserve fuel via improved operating procedures and long-term initiatives. The Incentivized Energy Conservation Program encourages the operation of ships in the most efficient manner while conducting their mission and supporting the Secretary of the Navy's efforts to reduce total energy consumption on naval ships. The Naval Sea Systems Command's Fleet Readiness, Research, and Development Program includes the High-Efficiency Heating, Ventilating, and Air Conditioning and the Hybrid Electric Drive for DDG-51 class ships, which are improvements to existing shipboard technologies that will both help with fleet readiness and decrease the ships' energy consumption and greenhouse gas emissions. These initiatives are expected to greatly reduce the consumption of fossil fuels (see Section 3.2, Air Quality). Furthermore, to offset the impact of its expected near-term increased fuel demands and achieve its goals to reduce fossil fuel consumption and greenhouse gas emissions, the Navy plans to deploy by 2016 a green strike group (a "great green fleet") composed of nuclear vessels and ships powered by biofuel in local operations and with aircraft flying only with biofuels (Jean 2010).

REFERENCES

Jean, G. V. (2010, April). Navy's Energy Reform Initiatives Raise Concerns Among Shipbuilders. *National Defense*, 4. Retrieved from http://www.nationaldefensemagazine.org/archive/2010/April/Pages/NavyEnergyReformRaiseConcerns.aspx

This Page Intentionally Left Blank

7 List of Preparers

TABLE OF CONTENTS

LIST OF TABLES

There are no tables in this section.

LIST OF FIGURES

There are no figures in this section.

This Page Intentionally Left Blank

7 LIST OF PREPARERS

7.1 GOVERNMENT PREPARERS

Anne P. Brooke (Naval Facilities Engineering Command, Marianas), Conservation Program Manager
Ph.D., Ethology
M.A., Ecology, Evolution and Behavior
B.A., Design

Valerie Curtis (Naval Facilities Engineering Command, Pacific), Archeologist
M.A., Anthropology
B.A., Anthropology

Meredith Fagan (Naval Facilities Engineering Command, Pacific), Natural Resources Management Specialist, Marine Resource Coordinator
B.A., Biology

Nora Gluch (Naval Sea Systems Command), NEPA Analyst and Research, Development, Testing, and Evaluation for Naval Sea Systems Command Activities
M.E.M., Coastal Environmental Management
B.A., Sociology

Sean Hanser (Naval Facilities Engineering Command, Pacific), Supervisory Natural Resources Management Specialist
Ph.D., Ecology

Frans Juola (Naval Facilities Engineering Command, Pacific), Wildlife Biologist, Avian Ecologist
Ph.D., Biology
M.S., Biology/Animal Behavior
B.A., Environmental Studies/Economic

Nora Macariola-See (Naval Facilities Engineering Command, Pacific), Project Manager
B.S., Chemical Engineering

Ken MacDowell (U.S. Navy Pacific Fleet), Training/Operations Environmental Support Commander USN (ret).
B.S., Liberal Studies

Morgan W. Richie (Naval Facilities Engineering Command, Pacific), Marine Resources Specialist
M.A.S., Marine Biodiviersity and Conservation
B.S., Zoology

Julie Rivers (U.S. Navy Pacific Fleet), Natural and Marine Resources Program Manager/Biologist
B.S., Biology

Roy Sokolowski (U.S. Navy Pacific Fleet), Environmental Protection Specialist/Acoustician
Submarine Sonar Technician Senior Chief Petty Officer, Acoustic Intelligence Specialist, USN (ret)

Robert Uyeyama (Naval Facilities Engineering Command, Pacific), Natural Resources Management Specialist
M.A., Psychology
Doctoral Studies, The Dolphin Institute

John Van Name (U.S. Navy Pacific Fleet), Project Lead
B.S., Mechanical Engineering

Thomas E. Vars (Naval Undersea Warfare Center Division Newport), Environmental Planner
B.S., Natural Resources

Kate L. Winters (Naval Facilities Engineering Command, Pacific), Marine Resource Specialist
Subject Matter Expert for Coral & Sea Turtles
Graduate Diploma, Marine Conservation & Genetics
B.S., Marine Biology & Zoology
JCU Graduate Certificate Underwater Photograph

7.2 CONTRACTOR PREPARERS

Elizabeth Becker (ManTech International Corporation), Senior Scientist
Ph.D., Marine Science
M.A., Geography
B.A., Geography and Environmental Studies
Years of Experience: 25

Susan Bupp (Parsons Government Services), Senior Cultural Resources Specialist
M.A., Anthropology
B.A., Anthropology
Years of Experience: 36

Joseph Campo (Parsons Government Services), Senior Project Manager
Ph.D., Wildlife Ecology
M.S., Wildlife Ecology
B.S., Forestry
Years of Experience: 29

Conrad Erkelens (ManTech International Corporation), Senior Scientist
M.A., Anthropology
B.A., Anthropology
Years of Experience: 17

Tania Fragomeno (Katz & Associates Inc.), Senior Account Executive
B.A., Psychology
Years of Experience: 11

Elvira Gaddi (Parsons Government Services), Senior Engineer
M.S., Chemical Engineering
B.S., Chemical Engineering
Years of Experience: 29

Taylor Houston (Parsons Government Services), Natural Resource Specialist/Project Manager
B.S., Natural Resource Management
Years of Experience: 13

Luke Huang (Parsons Government Services), Senior Scientist/Air Quality Specialist
M.S., Civil Engineering
B.S., Hydraulic Engineering
Years of Experience: 24

Sherrie Keenan (Parsons Government Services), Technical Editor
B.A., Journalism
Years of Experience: 25

Tammy Jo Moore (ManTech International Corporation), Resource Analyst
M.B.A., Management
B.S., Justice and Public Safety
Years of Experience: 18

Jonathon Nicholls (ManTech International Corporation), Military Operations Specialist
M.A., Business Management
B.S., Applied Mathematics
Years of Experience: 28

Jill Noel (Parsons Government Services), Botanist
M.A., Botany
M.S., Plant Biology
Years of Experience: 10

Kent Randall (ManTech International Corporation), Environmental Planner
J.D., Environmental Law, International Law
M.M.A., Marine Affairs: Marine Biology
B.A., International Studies
Years of Experience: 15

Allison Turner (Katz & Associates Inc.), Senior Director
M.S., Environmental Science
B.A., Social Science
Years of Experience: 9

Heather Turner (ManTech International Corporation), Marine Biologist
M.A.S., Marine Biodiversity and Conservation
B.S., Environmental Science
Years of Experience: 5

Karen Waller (ManTech International Corporation), Project Manager
B.S., Public Affairs
Years of Experience: 23

Lawrence Wolski (ManTech International Corporation), Marine Scientist
M.S., Marine Sciences
B.S., Biology
Years of Experience: 15

Mike Zickel (ManTech International Corporation), Environmental Scientist
M.S., Marine Estuarine Environmental Sciences
B.S., Physics
Years of Experience: 13

This Page Intentionally Left Blank

Appendix A: Training and Testing Activities Descriptions

TABLE OF CONTENTS

LIST OF TABLES

There are no tables in this section.

LIST OF FIGURES

APPENDIX A TRAINING AND TESTING ACTIVITIES DESCRIPTIONS

The United States (U.S.) Department of the Navy (Navy), Air Force, Army, Marine Corps, and Coast Guard have been conducting readiness activities throughout the Mariana Islands and the Pacific Ocean for decades. The tempo and types of training and testing activities have fluctuated within the Mariana Islands Training and Testing (MITT) Study Area (Study Area) due to changing requirements, the introduction of new technologies, the dynamic nature of international events, advances in warfighting doctrine and procedures, and force structure changes. Such developments have influenced the frequency, duration, intensity, and location of required training and testing.

A.1 TRAINING ACTIVITIES

The training activities are organized generally into eight primary mission areas and a miscellaneous category (other training) that includes those activities that do not fall within one of the eight primary mission areas, but are an essential part of training. Many of the activities described here may have a land component, or occur both at sea and on or over land.

In addition, because a number of activities are conducted within major range events, descriptions of those major range events are also included in this appendix. It is important to note that these major range events are comprised entirely of individual activities described in the primary mission areas.

A.1.1 Anti-Air Warfare Training

Anti-air warfare is the primary mission area that addresses combat operations by air and surface forces against hostile aircraft. Navy ships contain an array of modern anti-aircraft weapon systems, including naval guns linked to radar-directed fire-control systems, surface-to-air missile systems, and radar-controlled cannons for close-in point defense. Strike/fighter aircraft carry anti-aircraft weapons, including air-to-air missiles and aircraft cannons. Anti-air warfare training encompasses events and exercises to train ship and aircraft crews in employment of these weapons systems against simulated threat aircraft or targets. Anti-air warfare training includes surface-to-air gunnery, surface-to-air and air-to-air missile exercises, and aircraft force-on-force combat maneuvers.

A.1.1.1 Air Combat Maneuver

Activity Name	Activity Description	
Anti-Air Warfare		
Air Combat Maneuver (ACM)	Aircrews engage in flight maneuvers designed to gain a tactical advantage during combat.	
Long Description	Basic flight maneuvers where aircrew engage in offensive and defensive maneuvering against each other. During an air combat maneuver engagement, no ordnance is fired, countermeasures such as chaff and flares may be used. These maneuvers typically involve two aircraft; however, based upon the training requirement, air combat maneuver exercises may involve over a dozen aircraft. Participants typically are two or more aircraft. No weapons are fired.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft (e.g., F/A-18, F-35) **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** 1–2 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land: Special Use Airspace
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	No munitions fired. Flare and chaff may be used. All flare and chaff accounted for in flare exercise and chaff exercise events.	

A.1.1.2 Air Defense Exercise (ADEX)

Activity Name	**Activity Description**	
Anti-Air Warfare		
Air Defense Exercises (ADEX)	Aircrew and ship crews conduct defensive measures against threat aircraft or missiles.	
Long Description	Aircrew and ship personnel perform measures designed to defend against attacking threat aircraft or missiles or reduce the effectiveness of such attack. This exercise involves full detection though engagement sequence. Aircraft operate at varying altitudes and speeds. This exercise may include Air Intercept Control exercises which involve aircraft controllers on vessels, in fixed-wing aircraft or at land based locations, use search radars to track and direct friendly aircraft to intercept the threat aircraft, and Detect to Engage exercises in which personnel on vessels use their search radars in the process of detecting, classifying, and tracking enemy aircraft or missiles up to the point of engagement.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft (e.g., F/A-18, F-35, E-2), surface vessels (all) **Systems:** None **Ordnance/Munitions:** None **Targets:** Other aircraft, unmanned drones **Duration:** 1–4 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land: Special Use Airspace
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, vessel noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	No weapons fired.	

A.1.1.3 Air Intercept Control (AIC)

Activity Name	Activity Description
Anti-Air Warfare	
Air Intercept Control (AIC)	Aircrew and air controllers conduct aircraft intercepts of other aircraft.
Long Description	Fighter jet aircrews maneuver to defend against threat aircraft. An event involves two or more fighter aircraft.
Information Typical to the Event	**Platform:** Fixed- wing aircraft (e.g., F/A-18C, F-35) **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** 1–2 hours **Location:** Mariana Islands Training and Testing Study Area > 12 nm from land: Special Use Airspace
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** None
Detailed Military Expended Material Information	None
Assumptions used for Analysis	No weapons fired.

A.1.1.4 Gunnery Exercise (Air-to-Air) – Medium-Caliber

Activity Name	**Activity Description**	
Anti-Air Warfare		
Gunnery Exercise (Air-to-Air) Medium-Caliber **(GUNEX [A-A] – Medium-Caliber)**	Aircrews defend against threat aircraft with cannons (machine gun).	
Long Description	Fighter jet aircrews defend against threat aircraft with cannons (machine gun). An event involves two or more fighter aircrafts and a target banner towed by a contracted aircraft (e.g., Lear jet). The banner target is recovered after the event.	
Information Typical to the Event	**Platform:** Fixed- wing aircraft (e.g., F/A-18C, F-35) **Systems:** None **Ordnance/Munitions:** Medium-caliber projectile (non-explosive) **Targets:** Towed banner **Duration:** 1–2 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Military expended material (non-explosive projectile) strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** Medium-caliber projectiles, casings	
Detailed Military Expended Material Information	Projectiles Casings	
Assumptions used for Analysis	Only non-explosive munitions used. Target is recovered.	

A.1.1.5 Missile Exercise (Air-to-Air)

Activity Name	Activity Description	
Anti-Air Warfare		
Missile Exercise (Air-to-Air) (MISSILEX [A-A])	Aircrews defend against threat aircraft with missiles.	
Long Description	An event involves two or more jet aircraft and a target. Missiles have either a high-explosive warhead or are non-explosive practice munitions. The target is either an unmanned aerial target drone (e.g.: BQM-34, BQM-74), a Tactical Air-Launched Decoy, or a parachute suspended illumination flare. Target drones deploy parachutes and are recovered by boat or helicopter; Tactical Air-Launched Decoys and illumination flares are expended and not recovered. These events typically occur at high altitudes. Anti-air missiles may also be employed when training against threat missiles.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft (e.g., F/A-18C, F-35) **Systems:** None **Ordnance/Munitions:** Anti-air missiles (e.g., AIM-7, AIM-9, AIM-120, AIM-132 [non-explosive and high-explosive]) **Targets:** BQM-34, BQM-74 (Figure A-1), illumination flare (e.g., LUU-2) (Figure A-2), Tactical Air-Launched Decoy (Figure A-3) **Duration:** 1–2 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** None **Energy:** None **Physical Disturbance and Strike:** Military expended material strike (target and missile fragment), aircraft strike (birds only) **Entanglement:** Parachutes **Ingestion:** Military expended materials (missile fragments, parachute, flare casing, target fragments)	
Detailed Military Expended Material Information	Missile and target fragments. Parachutes. Flare casings.	
Assumptions used for Analysis	All missiles are explosive (Alternatives 1 and 2), and all missiles explode at high altitude. All propellant and explosives are consumed. Assume 1.5 flares per Missile Exercise event.	

Figure A-1: BQM-74 (Aerial Target)

Figure A-2: LUU-2B/B Illuminating Flare (Aerial Target)

Figure A-3: Tactical Air-Launched Decoy (Aerial Target)

A.1.1.6 Gunnery Exercise (Surface-to-Air) – Large-Caliber

Activity Name	Activity Description	
Anti-Air Warfare		
Gunnery Exercise (Surface-to-Air) – Large-Caliber **(GUNEX [S-A]) – Large-Caliber)**	Surface ship crews defend against threat aircraft or missiles with guns.	
Long Description	Surface vessel personnel defend against threat aircraft or missile targets with guns to disable or destroy the threat. An event involves one vessel and a simulated threat aircraft or anti-vessel missile that is detected by the vessel's radar. Large-caliber guns fire projectiles, either non-explosive or high-explosive (configured to explode in air); to disable or destroy the threat before it reaches the vessel. The target is towed by a commercial air services jet.	
Information Typical to the Event	**Platform:** Surface combatant vessel (e.g., CG, DDG, FFG, Littoral Combat Ship), fixed-wing aircraft **Systems:** None **Ordnance/Munitions:** Large-caliber (e.g., 5-inch gun, 76 mm, 57 mm [non-explosive] **Targets:** Towed banners behind aircraft **Duration:** 1–2 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, vessel noise, weapons firing noise, in-air explosives **Energy:** None **Physical Disturbance and Strike:** Military expended material strike (projectiles), vessel strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** Projectile fragments, target fragments	
Detailed Military Expended Material Information	Projectiles Target fragments	
Assumptions used for Analysis	All projectiles are assumed to be non-explosive.	

A.1.1.7 Gunnery Exercise (Surface-to-Air) – Medium-Caliber

Activity Name	Activity Description
Anti-Air Warfare	
Gunnery Exercise (Surface-to-Air) – Medium-Caliber **(GUNEX [S-A] – Medium-Caliber)**	Surface ship crews defend against threat aircraft or missiles with guns.
Long Description	Surface vessel personnel defend against threat aircraft or missile targets with guns to disable or destroy the threat. An event involves one vessel and a simulated threat aircraft or anti-vessel missile that is detected by the vessel's radar. Medium-caliber guns fire projectiles, typically non-explosive, to disable or destroy the threat before it reaches the vessel. The target is towed by a commercial air services jet.
Information Typical to the Event	**Platform:** Surface vessel, fixed-wing aircraft **Systems:** None **Ordnance/Munitions:** Medium-caliber munitions (non-explosive) **Targets:** Towed banners behind aircraft **Duration:** 1–2 hours **Location:** Mariana Islands Training and Testing Study Area, Special Use Airspace > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, vessel noise, weapons firing noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike (projectiles), vessel strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** Projectiles, casings
Detailed Military Expended Material Information	Projectiles Casings
Assumptions used for Analysis	All projectiles non-explosive. Close In Weapon System employed in all events. Routine Close In Weapon System maintenance related firing can occur throughout study area, as long as a clear range is established.

A.1.1.8 Missile Exercise (Surface-to-Air)

Activity Name	Activity Description	
Anti-Air Warfare		
Missile Exercise (Surface-to-Air) (MISSILEX [S-A])	Surface ship defends against threat missiles and aircraft with missiles.	
Long Description	Surface vessel crews defend against threat missiles and aircraft with vessel launched missiles. The event involves a simulated threat aircraft or anti-ship missile which is detected by the vessel's radar. Vessel launched anti-air missiles are fired (high-explosive) to disable or destroy the threat. The target typically is a remote controlled drone. Anti-Air missiles may also be used to train against land attack missiles.	
Information Typical to the Event	**Platform:** Surface vessels **Systems:** None **Ordnance/Munitions:** Anti-air missiles (e.g., Sea Sparrow, Standard Missile SM-2, Rolling Airframe Missile [high-explosive]) **Targets:** Unmanned drones (e.g., BQM-34, BQM-74) **Duration:** 1–2 hours	**Location:** Mariana Islands Training and Testing Study Area, Special Use Airspace > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, weapons firing noise, in-air explosives **Energy:** None **Physical Disturbance and Strike:** Military expended material strike (missile fragments), vessel strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** Missile fragments	
Detailed Military Expended Material Information	Missile fragments	
Assumptions used for Analysis	Assume all anti-air missiles are high-explosive. Missile explodes well above surface. All explosive and propellant consumed. Target typically not destroyed, unmanned drones are recovered.	

A.1.2 STRIKE WARFARE TRAINING

Strike warfare includes training of fixed-wing fighter/attack aircraft or rotary-wing aircraft in delivery of precision guided munitions, non-guided munitions, rockets, and other ordnance against land targets in all weather and light conditions. Training events typically involve a simulated strike mission with a flight of four or more aircraft. The strike mission may simulate attacks on “deep targets” (i.e., those geographically distant from friendly ground forces), or may simulate close air support of targets within close range of friendly ground forces. Laser designators from aircraft or ground personnel may be employed for delivery of precision guided munitions. Some strike missions involve no-drop events in which prosecution of targets is simulated, but video footage is often obtained by onboard sensors.

A.1.2.1 Bombing Exercise (Air-to-Ground)

Activity Name	Activity Description	
Strike Warfare		
Bombing Exercise (Air-to-Ground) **(BOMBEX [A-G])**	Fixed-wing aircraft drop bombs against a land target.	
Long Description	Bombing exercise involves training of bomber or strike fighter aircraft delivery of ordnance against land targets in day or night conditions. The bombing exercise may involve close air support training in direct support of and in close proximity to forces on the ground, such as Navy or Marine forces engaged in training exercises on land, and may include the use of targeting laser.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft **Systems:** Targeting laser systems **Ordnance/Munitions:** Typical: MK-76, BDU-45, and BDU-45 (non-explosive), and MK-80 series bombs (explosive) **Targets:** Land targets **Duration:** 1–2 hours	**Location:** Farallon de Medinilla
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, explosive noise **Energy:** Targeting laser **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	Bombs are released in accordance with range standard operating procedures. Land targets only.	

A.1.2.2 Gunnery Exercise (Air-to-Ground)

Activity Name	Activity Description	
Strike Warfare		
Gunnery Exercise (Air-to-Ground) **(GUNEX [A-G])**	Helicopter crews fire guns at stationary land targets; fixed-winged aircraft also strafe land targets.	
Long Description	Fixed-wing aircraft and helicopter crews use guns to attack ground targets, day or night, with the goal of destroying or disabling enemy vehicles, structures, or personnel. Aircraft will fire a burst of rounds, then break off and reposition for another strafing run until each aircraft expends its exercise ordnance allowance. This exercise may include the use of targeting laser.	
Information Typical to the Event	**Platform:** Fixed-wing and rotary-wing aircraft **Systems:** None **Ordnance/Munitions:** Small-, medium-, and large-caliber projectiles (e.g.,20/25/30 mm, 50-caliber and 7.63 mm, 105 mm) **Targets:** Land Targets **Duration:** 1 hour	**Location:** Farallon de Medinilla
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** Targeting laser **Physical Disturbance and Strike:** Air strike (birds only) **Entanglement:** None **Ingestion:** Projectile fragments and casings	
Detailed Military Expended Material Information	Projectile casings	
Assumptions used for Analysis	Land-based targets only.	

A.1.2.3 Missile Exercise

Activity Name	**Activity Description**	
Strike Warfare		
Missile Exercise (MISSILEX)	Missiles or rockets are launched against a land target.	
Long Description	Fixed-wing aircraft, helicopter, ship or submarine crews use missiles to attack ground targets, day or night, with the goal of destroying or disabling enemy vehicles, structures, or personnel.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft, helicopters, ships, submarines **Systems:** Targeting laser systems **Ordnance/Munitions:** Missiles or rockets (explosive) **Targets:** Land targets **Duration:** 1–2 hours	**Location:** Farallon de Medinilla
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft and missile/rocket noise **Energy:** Targeting laser **Physical Disturbance and Strike:** Vessel strike**,** airstrike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	Missile booster sections	
Assumptions used for Analysis	Land-based targets only	

A.1.2.4 Combat Search and Rescue

Activity Name	Activity Description
Strike Warfare	
Combat Search and Rescue (CSAR)	CSAR units use helicopters, night vision and identification systems, and insertion and extraction techniques under hostile conditions to locate, rescue, and extract personnel.
Long Description	An event involves two or more rescue aircraft.
Information Typical to the Event	**Platform:** Helicopters **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** 1–2 hours **Location:** Mariana Islands Range Complex; Rota Airport
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike **Entanglement:** None **Ingestion:** None
Detailed Military Expended Material Information	None
Assumptions used for Analysis	No weapons fired.

A.1.3 Amphibious Warfare Training

Amphibious warfare is a type of naval warfare involving the utilization of naval firepower and logistics, and Marine Corps landing forces to project military power ashore. Amphibious warfare encompasses a broad spectrum of operations involving maneuver from the sea to objectives ashore, ranging from reconnaissance or raid missions involving a small unit, to large-scale amphibious operations involving over one thousand Marines and Sailors, and multiple ships and aircraft embarked in a Strike Group.

Amphibious warfare training includes tasks at increasing levels of complexity, from individual, crew, and small unit events to large task force exercises. Individual and crew training include the operation of amphibious vehicles and naval gunfire support training. Small-unit training operations include events leading to the certification of a Marine Expeditionary Unit as “deployment ready” or “special operations capable,” depending on if Marine Special Forces are attached to the unit. Such training includes shore assaults, boat raids, airfield or port seizures, and reconnaissance. Larger-scale amphibious exercises involve ship-to-shore maneuver, shore bombardment and other naval fire support, and air strike and close air support training.

A.1.3.1 Naval Surface Fire Support Exercise – Land-Based Target

Activity Name	**Activity Description**	
Amphibious Warfare		
Naval Surface Fire Support Exercise – Land-Based Target (FIREX [Land])	Surface ship crews use large-caliber guns to fire on land-based targets in support of forces ashore.	
Long Description	One or more vessels position themselves offshore the target area and a land or air based spotter relays type and exact location of the target. After observing the fall of the shot, the spotter relays any adjustments needed to reach the target. Once the rounds are on target, the spotter requests a sufficient number to effectively destroy the target. This exercise occurs on land ranges where high-explosive and non-explosive practice ordnance is authorized and may be supported by target shapes on the ground.	
Information Typical to the Event	**Platform:** Surface combatant vessels (e.g., CG, DDG) **Systems:** None **Ordnance/Munitions:** large-caliber (explosive and non-explosive) **Targets:** Land targets **Duration:** 4–6 hours	**Location:** Farallon de Medinilla
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, weapons firing noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike **Entanglement:** None **Ingestion:** Projectile fragments and casings	
Detailed Military Expended Material Information	Casings	
Assumptions used for Analysis	Land-based targets	

A.1.3.2 Amphibious Rehearsal, No Landing – Marine Air Ground Task Force

Activity Name	Activity Description	
Amphibious Warfare		
Amphibious Rehearsal, No Landing – Marine Air Ground Task Force	Amphibious shipping, landing craft, and aviation elements of the Marine Air Ground Task Force rehearse amphibious landing operations without conducting an actual landing on shore.	
Long Description	Amphibious vessels maneuver to position, flood well decks, and launch and recover landing craft including hovercraft, combat rubber raiding craft, armored amphibious craft, landing craft ship, and task force aircraft in assault landing rehearsals. Assault craft form landing waves and approach shore without landing.	
Information Typical to the Event	**Platform:** Amphibious shipping, amphibious assault craft, and fixed wing, rotary, and tilt rotor aircraft **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** 1–2 days	**Location:** Study Area and Nearshore
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	Assault craft turn away before entering surf zone or landing zone. Typical event: 1–3 amphibious vessels (e.g., LHA or LHD, LPD, LSD); 2-8 landing craft (Landing Craft, Air Cushioned; Landing Craft, Utility); 4–14 amphibious assault vehicles; up to 22 aircraft (e.g., MH-53, H-46/MV-22, AH-1, UH-1, AV-8); a Marine Expeditionary Unit (2,200 Marines)	

A.1.3.3 Amphibious Assault

Activity Name	Activity Description
Amphibious Warfare	
Amphibious Assault	Forces move ashore from ships at sea for the immediate execution of inland objectives.
Long Description	Landing forces embarked in vessels, craft, or tilt-rotor and helicopters launch an attack from the sea onto a hostile shore. Amphibious assault is conducted for the purposes of prosecuting further combat operations, obtaining a site for an advanced naval or airbase, or denying the enemy use of an area. Unit Level Training exercises involve one or more amphibious vessels, and their associated watercraft and aircraft, to move personnel and equipment from vessel to shore without the command and control and supporting elements involved in a full scale event. The goal is to practice loading, unloading, and movement and to develop the timing required for a full-scale exercise.
Information Typical to the Event	**Platform:** Amphibious and landing vessels (e.g., LHA, LHD, LPD, LSD), amphibious vehicles, fixed wing, rotary and tilt-rotor aircraft **Systems:** None **Ordnance/Munitions:** Blanks, Simunitions **Targets:** None **Duration:** Up to 2 weeks **Location:** Mariana Islands Range Complex; Tinian; Guam
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, aircraft strike (birds only), vehicle strike (pedestrian), physical disturbance (coral, sea-turtle nests) **Entanglement:** None **Ingestion:** None
Detailed Military Expended Material Information	None
Assumptions used for Analysis	Typical event: 1–3 amphibious vessels (e.g., LHA or LHD, LPD, LSD); 2–8 landing craft (Landing Craft, Air Cushioned; Landing Craft, Utility); 4–14 amphibious assault vehicles; up to 22 aircraft (e.g., MH-53, H-46/MV-22, AH-1, UH-1, AV-8); a Marine Expeditionary Unit (2,200 Marines)

A.1.3.4 Amphibious Raid

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Amphibious Warfare</td></tr>
<tr><td>Amphibious Raid</td><td colspan="2">Small unit forces move swiftly from ships at sea for a specific short term mission. These are quick operations with raids sized to the mission requirement and no larger.</td></tr>
<tr><td>Long Description</td><td colspan="2">Small unit forces swiftly move from amphibious vessels at sea into hostile territory for a specific mission, including a planned withdrawal. Raids are conducted to inflict loss or damage, secure information, create a diversion, confuse the enemy, or capture or evacuate individuals or material. Amphibious raid forces are sized to maximize stealth and speed of the operation.
An event may employ assault amphibian vehicle units, small boat units, small unit live-fire and non-live-fire operations. Surveillance or reconnaissance unmanned surface and aerial vehicles may be used during this event.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Amphibious assault vessels (e.g., LHA, LHD), amphibious transport dock and dock landing ships (e.g., LPD, LSD), amphibious vehicles (landing crafts, air cushioned, and amphibious assault vehicles), small boats (e.g., rigid-hull inflatable boats)
Systems: Unmanned surface and aerial vehicles
Ordnance/Munitions: Blanks, Simunitions.
Targets: None
Duration: 4–8 hours</td><td>Location:
Mariana Islands Range Complex; Tinian; Guam; Rota</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Vessel noise, weapons firing noise
Energy: None
Physical Disturbance and Strike: Vessel strike, vehicle strike (pedestrian), physical disturbance (coral, sea-turtle nests)
Entanglement: None
Ingestion: None</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">None</td></tr>
<tr><td>Assumptions used for Analysis</td><td colspan="2">Small-caliber weapons with training blanks and Simunitions. Firing of weapons at sea during these events accounted for in gunnery exercises, surface to surface activities.</td></tr>
</table>

A.1.3.5 Urban Warfare Training

Activity Name	Activity Description	
Amphibious Warfare		
Urban Warfare Training	Forces sized from squad (13 Marines) to battalions (approximately 950) conduct training activities in mock urban environments.	
Long Description	Military units provide integrated and effective ground and air support for maneuver and battle in an urban environment	
Information Typical to the Event	**Platform:** Trucks, unmanned aerial vehicles, rotor and tilt-rotor aircraft, fixed-wing strike fighter or attack aircraft **Systems:** **Ordnance/Munitions:** Blanks, Simunitions **Targets:** None **Duration:** 8 days	**Location:** Mariana Islands Range Complex; Tinian; Guam
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike. **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	Land-based activity.	

A.1.3.6 Noncombatant Evacuation Operation

Activity Name	Activity Description	
Amphibious Warfare		
Noncombatant Evacuation Operation	Military units evacuate noncombatants from hostile or unsafe areas or provide humanitarian assistance in times of disaster	
Long Description	Military units provide integrated and effective vessel, ground, and close air support, in support of task force operations to evacuate noncombatants.	
Information Typical to the Event	**Platform:** Surface vessels, amphibious vessels, rotary-wing and tilt rotor aircraft, fixed-wing strike fighter or attack aircraft, unmanned aerial vehicles **Systems:** None **Ordnance/Munitions:** Blanks, Simunitions **Targets:** None **Duration:** 5 days	**Location:** Mariana Islands Range Complex; Guam; Tinian; Rota
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** None **Energy:** None **Physical Disturbance and Strike:** Aircraft strike, vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	Sea-, land-, and air-based activity.	

A.1.3.7 Humanitarian Assistance Operations/Disaster Relief Operations

Activity Name	Activity Description
Amphibious Warfare	
Humanitarian Assistance Operation/Disaster Relief Operations	Military units evacuate noncombatants from hostile or unsafe areas or provide humanitarian assistance in times of disaster.
Long Description	Military units evacuate noncombatants from hostile or unsafe areas to safe havens or to provide humanitarian assistance in times of disaster. Non-Combatant Evacuation Operation is conducted by military units (generally Marine Corps) usually operating in conjunction with Navy ships and aircraft. Noncombatants are evacuated when their lives are endangered by war, civil unrest, or natural disaster. Marine Corps Marine expeditionary unit train for evacuations in hostile environments that require the use of force, though usually there is no opposition to evacuation from the host country. Helicopters and landing crafts could be expected to participate in this operation during day or night. No ordnance is used.
Information Typical to the Event	**Platform:** Rotary, tilt-rotor and fixed-wing aircraft, amphibious vessels **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** Varies **Location:** Mariana Islands Range Complex; Guam; Tinian; Rota
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike, vessel strike **Entanglement:** None **Ingestion:** None
Detailed Military Expended Material Information	None
Assumptions used for Analysis	Sea-, land-, and air-based activity.

A.1.3.8 Unmanned Aerial Vehicle – Intelligence, Surveillance, and Reconnaissance

Activity Name	**Activity Description**	
Amphibious Warfare		
Unmanned Aerial Vehicles Ops (UAV OPS)	Military units employ unmanned aerial vehicles to launch, operate, and gather intelligence for specified amphibious missions.	
Long Description	Unmanned aerial vehicles may be launched from ships or ground and are used to gather tactical or theater level intelligence.	
Information Typical to the Event	**Platform:** Rotary and fixed-wing aircraft, vessels **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** Varies	**Location:** Mariana Islands Range Complex; Special Use Airspace
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, vessel noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike, vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	Sea-, land-, and air-based activity.	

A.1.4 Anti-Surface Warfare Training

Anti-surface warfare is a type of naval warfare in which aircraft, surface ships, and submarines employ weapons and sensors in operations directed against enemy surface ships or boats. Air-to-surface exercises are conducted by long-range attacks using air-launched cruise missiles or other precision guided munitions, or using aircraft cannon. Anti-surface warfare also is conducted by warships employing torpedoes, naval guns, and surface-to-surface missiles. Submarines attack surface ships using torpedoes or submarine-launched, anti-ship cruise missiles. Training in anti-surface warfare includes surface-to-surface gunnery and missile exercises, air-to-surface gunnery and missile exercises, and submarine missile or torpedo launch events. Gunnery and missile training generally involves expenditure of ordnance against a towed target. A sinking exercise is a specialized training event that provides an opportunity for ship, submarine, and aircraft crews to use multiple weapons systems to deliver high-explosive ordnance on a deactivated vessel, which is deliberately sunk.

Anti-surface warfare also encompasses maritime security, that is, the interception of a suspect surface ship by a Navy ship for the purpose of boarding-party inspection or the seizure of the suspect ship. Training in these tasks is conducted in visit, board, search and seizure exercises.

A.1.4.1 Gunnery Exercise (Air-to-Surface) – Small-Caliber

Activity Name	Activity Description	
Anti-Surface Warfare		
Gunnery Exercise (Air-to-Surface) – Small-Caliber	**Short Description:** Helicopter aircrews, including embarked personnel, use small-caliber guns to engage surface targets.	
Long Description	Helicopters, carrying several air crewmen, fly a racetrack pattern around an at-sea target. Each gunner will engage the target with small-caliber weapons. Targets range from a smoke float, an empty steel drum, to high speed remote controlled boats and jet-skis.	
Information Typical to the Event	**Platform:** Helicopter **Systems:** None **Ordnance/Munitions:** Small-caliber (non-explosive) **Targets:** Recoverable or expendable floating target (stationary or towed), remote high speed target **Duration:** 1 hour	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** In-water device strike, military expended material strike (projectiles, target fragments), aircraft strike (birds only) **Entanglement:** None **Ingestion:** Projectiles, target fragments, casings	
Detailed Military Expended Material Information	Projectiles, target fragments, casings	
Assumptions used for Analysis	One target used per event. Expendable smoke float (50 percent), stationary target (45 percent), or remote controlled target (5 percent).	

A.1.4.2 Gunnery Exercise (Air-to-Surface) – Medium-Caliber

Activity Name	**Activity Description**	
Anti-Surface Warfare		
Gunnery Exercise (Air-to-Surface) – Medium-Caliber	Fixed-wing and helicopter aircrews, including embarked personnel, use medium-caliber guns to engage surface targets.	
Long Description	Fighter and helicopter aircrew, including embarked personnel, engage surface targets with medium-caliber guns. Targets simulate enemy ships, boats, swimmers, and floating/near-surface mines. Fighter aircraft descend on a target firing high-explosive or non-explosive practice munitions medium-caliber projectiles. Helicopters, carrying several air crewmen, fly a racetrack pattern around an at-sea target. Crew will engage the target with medium-caliber weapons. Targets range from a smoke float, an empty steel drum, to high speed remote controlled boats and jet-skis.	
Information Typical to the Event	**Platform:** Fixed-wing (e.g., F/A-18, F-35); Helicopter (e.g., MH-60) **Systems:** None **Ordnance/Munitions:** Medium-caliber (non-explosive and explosive) **Targets:** Recoverable or expendable floating target (stationary or towed), Remote high speed target **Duration:** 1 hour	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land; Transit Corridor
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Underwater explosions (E1), aircraft noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike (projectile, target fragments), in-water device strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** Projectile, casings and target fragments	
Detailed Military Expended Material Information	Projectiles, casings, projectile and target fragments One target used per event. Expendable smoke float (50 percent), stationary target (45 percent), or remote controlled target (5 percent).	
Assumptions used for Analysis	Most medium-caliber air-to-surface gunnery exercises will be with non-explosive training projectiles. High-explosive rounds will supplement when non-explosive training projectiles are not available.	

A.1.4.3 Missile Exercise (Air-to-Surface) – Rocket

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Anti-Surface Warfare</td></tr>
<tr><td>Missile Exercise (Air-to-Surface) Rocket
(MISSILEX [A-S]) – Rocket)</td><td colspan="2">Fixed-wing and helicopter aircrew fire precision-guided/unguided rockets against surface targets.</td></tr>
<tr><td>Long Description</td><td colspan="2">Fighter, maritime patrol aircraft, and helicopter aircrews fire precision-guided/unguided rockets against surface targets. Aircraft involved may be unmanned.
Fixed-wing aircraft (fighters or maritime patrol aircraft) approach an at-sea surface target from high altitude and launch precision guided/unguided rockets.
Helicopters designate an at-sea surface target with a laser or optics for precision guided rockets.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Fixed-wing (e.g., F/A18, F-35, P-8, P-3, unmanned aerial vehicle) Helicopters (MH-60, Fire Scout)
Systems: None
Ordnance/Munitions: Rockets (explosive)
Targets: Recoverable floating target (stationary or towed)
Duration: 1 hour</td><td>Location:
Mariana Islands Training and Testing Study Area > 12 nm from land</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Underwater explosions (E5), aircraft noise
Energy: Target Laser
Physical Disturbance and Strike: In-water device strike, military expended material strike (rocket, rocket and target fragments)
Entanglement: None
Ingestion: Target fragments, rocket fragments</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">Rockets, rocket fragments
Target fragments</td></tr>
<tr><td>Assumptions used for Analysis</td><td colspan="2">Assume all rockets are explosive and detonate in water.</td></tr>
</table>

A.1.4.4 Missile Exercise (Air-to-Surface)

Activity Name	Activity Description	
Anti-Surface Warfare		
Missile Exercise (Air-to-Surface) **(MISSILEX [A-S])**	Fixed-wing and helicopter aircrews fire precision-guided missiles against surface targets.	
Long Description	Fighter, maritime patrol aircraft, and helicopter aircrews fire both precision-guided missiles and unguided rockets against surface targets. Aircraft involved may be unmanned. Fixed-wing aircraft (fighters or maritime patrol aircraft) approach an at-sea surface target from high altitude, and launch high-explosive precision guided missiles. Helicopters designate an at-sea surface target with a laser or optics for a precision guided high-explosive missile. Helicopter launched missiles typically pass through the target's "sail," and detonate at, or just below, the water's surface.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft and helicopters **Systems:** None **Ordnance/Munitions:** Missiles (high-explosive or non-explosive) **Targets:** Recoverable floating target (stationary or towed), Remotely operated target **Duration:** 2 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Underwater explosions (E6, E8, E10), aircraft noise, tow vessel noise **Energy:** None **Physical Disturbance and Strike:** In-water device strike, military expended material strike (missile fragment), aircraft strike (birds only) **Entanglement:** None **Ingestion:** Missile fragments, target fragments	
Detailed Military Expended Material Information	Missile fragments Target fragments	
Assumptions used for Analysis	Assume one explosive missile and one target per event. While missile could explode above water's surface after contacting target, analysis assumes all warheads explode at or just below surface.	

A.1.4.5 Laser Targeting (At Sea)

Activity Name	Activity Description	
Anti-Surface Warfare		
Laser Targeting (At Sea)	Fixed-winged, helicopter, and ship crews illuminate enemy targets with lasers.	
Long Description	Fixed-winged and helicopter aircrew and shipboard personnel illuminate enemy targets with lasers for engagement by aircraft with laser guided bombs or missiles. This exercise may be conducted alone or in conjunction with other events utilizing precision guided munitions, such as anti-surface missiles and guided rockets. Events where weapons are fired are addressed in the appropriate activity (e.g., air-to-surface missile exercise). Lower powered lasers may also be used as non-lethal deterrents during maritime security operations (force protection).	
Information Typical to the Event	**Platform:** Vessels, fixed-wing aircraft, rotary-wing aircraft **Systems:** None **Ordnance/Munitions:** None unless conducted with other event (e.g., missile exercise) **Targets:** Land targets, Remote-controlled surface targets **Duration:** 1–2 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, aircraft noise **Energy:** In-air low energy lasers **Physical Disturbance and Strike:** Vessel strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	Laser targeting for missile/rocket guidance will occur in areas where these events also occur.	

A.1.4.6 Bombing Exercise (Air-to-Surface)

Activity Name	Activity Description	
Anti-Surface Warfare		
Bombing Exercise (Air-to-Surface) (BOMBEX [A-S])	Fixed-wing aircrews deliver bombs against surface targets.	
Long Description	Fixed-wing aircrews deliver bombs against surface targets. Fixed-wing aircraft conduct a bombing exercise against stationary floating targets (e.g., MK-58 smoke buoy). An aircraft clears the area, deploys a smoke buoy or other floating target, and then delivers high-explosive or non-explosive practice munitions bomb(s) on the target. A range boat may be used to deploy targets for an aircraft to attack. Exercises for strike fighters typically involve a flight of two aircraft delivering unguided or guided munitions that may be either high-explosive or non-explosive practice munitions. The following munitions may be employed by aircraft in the course of the bombing exercise: Typical unguided munitions: Non-explosive Sub Scale Bombs (MK-76 and BDU-45); explosive and non-explosive general purpose bombs (MK-80 series). Precision-guided munitions: Laser-guided bombs (explosive, non-explosive); Laser-guided Training Rounds (non-explosive); Joint Direct Attack Munition (explosive, non-explosive).	
Information Typical to the Event	**Platform:** Fixed-wing **Systems:** None **Ordnance/Munitions:** Bombs (e.g., MK-76, BDU-45, MK-80 series [high-explosive, non-explosive]) **Targets:** Expendable floating target (e.g., smoke float) **Duration:** 1 hour	**Location:** Mariana Islands Training and Testing Study Area > 50 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Underwater explosions (e.g., E12), aircraft noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike (non-explosive bomb), aircraft strike (birds only) **Entanglement:** None **Ingestion:** Bomb fragments, target fragments, smoke floats	
Detailed Military Expended Material Information	Bomb fragments Target fragments Smoke floats	
Assumptions used for Analysis	Explosive bombs are assumed to explode just beneath the surface. Approximately 90 percent of non-explosive bombs are the sub-scale bombs such as the MK-76 and BDU-48.	

A.1.4.7 Torpedo Exercise (Submarine-to-Surface)

Activity Name	Activity Description	
Anti-Surface Warfare		
Torpedo Exercise (Submarine-to-Surface)	Submarine attacks a surface target using exercise or live-fire torpedoes.	
Long Description	Submarines track and engage a surface target with non-explosive exercise torpedoes.	
Information Typical to the Event	**Platform:** Submarine, helicopter or vessel torpedo retrieval craft **Systems:** None **Ordnance/Munitions:** Non-explosive exercise torpedo **Targets:** Surface vessel **Duration:** 2–4 hours	**Location:** Mariana Islands Training and Testing Study Area > 3 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, hull mounted sonar (MF3), heavyweight torpedo (TORP2), aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel and in-water device strike **Entanglement:** Guidance wire **Ingestion:** None	
Detailed Military Expended Material Information	Guidance wire	
Assumptions used for Analysis	The exercise torpedo is recovered by a support craft or helicopter.	

A.1.4.8 Missile Exercise (Surface-to-Surface)

Activity Name	Activity Description
Anti-Surface Warfare	
Missile Exercise (Surface-to-Surface) (MISSILEX [S-S])	Surface vessel crews defend against surface vessel threats with missiles.
Long Description	Surface vessels launch missiles at surface maritime targets with the goal of destroying or disabling enemy vessels or boats. After detecting and confirming a surface threat, the vessel will fire precision guided anti-surface missile. Events with destroyers and cruisers will involve long range (over the horizon) harpoon (or similar) anti surface missiles. While past harpoon events occurred during sinking exercises, requirement exists for non-sinking exercise events to certify ship crews. If a sinking exercise target is unavailable, towed sled would likely be used. Events with Littoral Combat Ships may involve shorter range anti-surface missiles. Events with Littoral Combat Ships would be to certify vessel's crew to defend against "close in" (less than 10 miles) surface threats. These exercises are live fire, that is, a missile is fired down range. Anti-surface missiles could be equipped with either high-explosive or non-explosive warheads.
Information Typical to the Event	**Platform:** Surface vessels (e.g., CG, DDG, LCS) **Systems:** None **Ordnance/Munitions:** Anti-surface missiles, Harpoons (explosive and non-explosive) **Targets:** High speed surface targets, towed sleds **Duration:** 2–4 hours **Location:** Mariana Islands Training and Testing Study Area > 50 nm from land nm
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Underwater explosions (e.g., E6, E10), vessel noise, weapons firing noise **Energy:** None **Physical Disturbance and Strike:** Vessel and in-water device strike, military expended material strike (missile and target fragments) **Entanglement:** None **Ingestion:** Missile fragments, target fragments
Detailed Military Expended Material Information	Missiles, missile fragments Target fragments
Assumptions used for Analysis	Assume one missile and one target per event. While missile could explode above water's surface after contacting target, analysis assumes all warheads explode at or just below surface.

A.1.4.9 Gunnery Exercise (Surface-to-Surface) Ship – Large-Caliber

Activity Name	Activity Description
Anti-Surface Warfare	
Gunnery Exercise Surface-to-Surface (Ship) – Large-Caliber (GUNEX [S-S] Ship – Large-Caliber)	Ship crews engage surface targets with ship's large-caliber guns.
Long Description	This exercise involves vessels' gun crews engaging surface targets at sea with their large-caliber (typically 57 mm, 76 mm, and 5-inch) guns. Targets may include the QST-35 (Figure A-5: QST-35 Seaborne Powered Target seaborne powered target, high speed maneuverable surface target, or a specially configured remote controlled water craft. Some targets are expended during the exercise and are not recovered. The exercise proceeds with the target boat approaching from about 10 nm distance. The target is tracked by radar and when within a predetermined range, it is engaged first with "warning shots." As threats get closer all weapons may be used to disable the threat. This exercise may involve a single firing vessel, or be undertaken in the context of a coordinated larger exercise involving multiple ships, including a major training event. Large-caliber guns will also be fired during weapon certification events and in conjunction with weapon maintenance. During all events, either high-explosive or non-explosive rounds may be used. High explosive rounds can either be fused for detonation on impact (with water surface or target), or for proximity to the target (in air detonation).
Information Typical to the Event	**Platform:** Surface combatant vessels **Systems:** None **Ordnance/Munitions:** Large-caliber (e.g., 57 mm, 76 mm, and 5-inch [high-explosive and non-explosive]) **Targets:** Remote controlled high speed targets **Duration:** Up to 3 hours **Location:** Mariana Islands Training and Testing Study Area > 12 nm from land; Transit corridor
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Underwater explosions (e.g., E3, E5), vessel noise, weapons firing noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, target strike, military expended material strike (projectile, target fragments) **Entanglement:** None **Ingestion:** Target fragments, projectile fragments
Detailed Military Expended Material Information	Large-caliber projectiles and casings Target fragments Projectile fragments
Assumptions used for Analysis	For analytical purposes assume all high-explosive rounds are fused to detonate upon impact with water surface or target. After impacting the water, the high-explosive rounds are expected to detonate within three feet of the surface. Non-explosive rounds and fragments from the high-explosive rounds will sink to the bottom of the ocean. Assume each non-explosive projectile will be up to 5-inch diameter.

A.1.4.10 Gunnery Exercise (Surface-to-Surface) Ship – Small-Caliber and Medium-Caliber

Activity Name	Activity Description	
Anti-Surface Warfare		
Gunnery Exercise Surface-to-Surface (Ship) – Small-Caliber and Medium-Caliber **(GUNEX [S-S] Ship – Small-Caliber and Medium-Caliber)**	Ship crews engage surface targets with ship's small- and medium-caliber guns.	
Long Description	This exercise involves vessel crews engaging surface targets at sea with small-caliber and medium-caliber weapons. Vessels use small- and medium-caliber weapons to practice defensive marksmanship, typically against a stationary floating target (a 10-foot diameter red balloon [Killer Tomato]) (Figure A-4) and high speed mobile targets. Some targets are expended during the exercise and are not recovered. Shipboard protection systems (Phalanx Close-In Weapon System) utilizing medium-caliber projectiles will train against high speed mobile targets.	
Information Typical to the Event	**Platform:** Surface vessels **Systems:** None **Ordnance/Munitions:** Medium-caliber (high-explosive or non-explosive) **Targets:** Recoverable and expendable floating target (stationary or towed), remote control high-speed targets **Duration:** 2–3 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land; Transit Corridor
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Underwater explosives (E1), vessel noise, weapons firing noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, target strike, military expended material strike (projectiles) **Entanglement:** None **Ingestion:** Medium-caliber projectiles and casings, target fragments, projectile fragments	
Detailed Military Expended Material Information	Small- and medium-caliber projectiles and casings, target fragments, projectile fragments Approximately 200 small- and medium-caliber rounds per event One target used per event. Approximately 50 percent of targets are “Killer Tomatoes” (usually recovered) (Figure A-4). Approximately 35 percent are high-speed maneuvering targets, which are recovered. Approximately 15 percent of targets are other stationary targets such as a steel drum.	
Assumptions used for Analysis	None	

A.1.4.11 Sinking Exercise (SINKEX)

Activity Name	**Activity Description**	
Anti-Surface Warfare		
Sinking Exercise (SINKEX)	Aircraft, ship, and submarine crews deliver ordnance on a seaborne target, usually a deactivated ship, which is deliberately sunk using multiple weapon systems.	
Long Description	Ship personnel and aircrew deliver high-explosive ordnance on a seaborne target, (large deactivated vessel), which is deliberately sunk using multiple weapon systems. A sinking exercise is typically conducted by aircraft, surface vessels, and submarines in order to take advantage of the ability to fire high-explosive ordnance on a full size ship target. The target is typically a decommissioned ship made environmentally safe for sinking according to U.S. Environmental Protection Agency standards. The location is greater than 50 nautical miles from shore and in water depths greater than 6,000 feet. Vessel, aircraft, and submarine crews attack with coordinated tactics and deliver live high-explosive ordnance to sink the target. Non-explosive practice munitions may be used during the initial stages to extend target life. Typically, the exercise lasts for 4–8 hours and possibly over 1–2 days, however it is unpredictable, and ultimately ends when the ship sinks.	
Information Typical to the Event	**Platform:** Vessels, Aircraft, Submarines **Systems:** None **Ordnance/Munitions:** Potentially all available (explosive and non-explosive), torpedo **Targets:** Decommissioned ship made environmentally safe for sinking (according to U.S. Environmental Protection Agency standards) **Duration:** 4–8 hours, possibly over 1–2 days (unpredictable and ultimately ends when the ship sinks)	**Location:** Mariana Islands Training and Testing Study Area > 50 nm from land in water depths > 6,000 feet
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Underwater explosions (e.g., E5, E8, E9, E11), vessel noise, aircraft noise, weapons firing noise **Energy:** In-air low energy lasers **Physical Disturbance and Strike:** Military expended material strike (non-explosive projectiles, projectile fragments), vessel strike, aircraft strike (birds only) **Entanglement:** Guidance wires **Ingestion:** Munitions fragments, casings	
Detailed Military Expended Material Information	Munitions fragments, non-explosive ordnance, guidance wires, casings Ship hulk (decommissioned ship made environmentally safe for sinking according to U.S. Environmental Protection Agency standards)	

Sinking Exercise (SINKEX) (continued)

Activity Name	Activity Description
Anti-Surface Warfare	
Assumptions used for Analysis *(Representative ordnance. Actual ordnance used will vary [typically less than shown])*	Greater than 50 nautical miles from shore and in water depths greater than 6,000 feet Typical participants and assets: • One full-size target ship hulk • One to five ships • One to 10 fixed-wing aircraft • One or two combatant helicopters • One Command and Control aircraft • One submarine • One to three range clearance aircraft • Nine to 42 explosive missiles • Two to 28 bombs • Fifty to 800 large caliber rounds • One to two heavyweight submarine-launched torpedo • One to four explosive demolitions • Assume 2 guidance wires expended per event

A.1.4.12 Gunnery Exercise (Surface-to-Surface) Boat – Small-Caliber and Medium-Caliber

Activity Name	Activity Description	
Anti-Surface Warfare		
Gunnery Exercise Surface-to-Surface (Boat) – Small-Caliber and Medium-Caliber **(GUNEX [S-S] Boat)**	Small boat crews engage surface targets with small- and medium-caliber weapons.	
Long Description	Boat crews engage surface targets with small- and medium-caliber weapons. Boat crews may use high or low speeds to approach and engage targets simulating other boats, floating mines, or near shore land targets with small- and medium-caliber (up to and including 40mm) weapons. A commonly used target is an empty steel drum. A number of different types of boats are used depending on the unit using the boat and their mission. Boats are most used to protect ships in harbors and high value units, such as: aircraft carriers, nuclear submarines, liquid natural gas tankers, etc., while entering and leaving ports, as well as to conduct riverine operations, and various naval special warfare operations. The boats used by these units include: small unit river craft, combat rubber raiding craft, rigid-hull inflatable boats, patrol craft, and many other versions of these types of boats. These boats use inboard or outboard, diesel or gasoline engines with either propeller or water jet propulsion.	
Information Typical to the Event	**Platform:** Boats **Systems:** None **Ordnance/Munitions:** Small- and medium-caliber (up to and including 40mm [explosive and non-explosive]) **Targets:** Recoverable or expendable floating target (Figure A-4) (stationary or towed) **Duration:** 1 hour	**Location:** Mariana Islands Training and Testing Study Area >12 nm [explosive rounds] Study Area > 3 nm from land [non-explosive rounds] Transit Corridor
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Underwater explosions (E2), vessel noise, weapons firing noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike (projectile, target fragments), vessel and in-water device strike **Entanglement:** None **Ingestion:** Projectiles and target fragments, projectiles, casings	
Detailed Military Expended Material Information	Projectiles and target fragments, projectiles, casings One target used per event, typically a stationary target such as a 50-gallon (189-liter) steel drum.	
Assumptions used for Analysis	Assume all Alternatives 1 and 2 events include the use of some explosive rounds. Most events will involve boat crews training with MK 203 40mm grenade launcher.	

A.1.4.13 Maritime Security Operations (MSO)

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Anti-Surface Warfare</td></tr>
<tr><td>Maritime Security Operations (MSO)</td><td colspan="2">Helicopter and surface ship crews conduct a suite of Maritime Security Operations (e.g., Vessel, Search, Board, and Seizure; Maritime Interdiction Operations; Force Protection; and Anti-Piracy Operation).</td></tr>
<tr><td>Long Description</td><td colspan="2">Helicopter and surface ship crews conduct a suite of Maritime Security Operations (e.g., visit search, board, and seizure; maritime interdiction operations; force protection; and anti-piracy operation). These activities involve training of boarding parties delivered by helicopters and surface ships to surface vessels for the purpose of simulating vessel search and seizure operations. Various training scenarios are employed and may include small arms with non-explosive blanks and surveillance or reconnaissance unmanned surface and aerial vehicles, and anti-swimmer grenades. The entire exercise may last 2–3 hours.
Vessel Visit, Board, Search, and Seizure: Military personnel from vessels and aircraft board suspect vessels, potentially under hostile conditions.
Maritime Interdiction Operations: Vessels and aircraft train in pursuing, intercepting, and ultimately detaining suspect vessels.
Oil Platform Defense: Naval personnel train to defend oil platforms or other similar at sea structures.
Warning Shot/Disabling Fire: Naval personnel train in the use of weapons to force fleeing or threatening small boats (typically operating at high speeds) to come to a stop.
Ship Force Protection: Vessel crews train in tracking multiple approaching, circling small craft, assessing threat potential, and communicating amongst crewmates and other vessels to ensure vessels are protected against attack.
Anti-Piracy Training: Naval personnel train in deterring and interrupting piracy activity. Training includes large vessels (pirate “mother ships”), and multiple small, maneuverable, and fast craft.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Surface vessel (any), rotary-wing aircraft, small boats, high speed vessels, unmanned vehicles (surface and aerial)
Systems: None
Ordnance/Munitions: Small-caliber (non-explosive) and anti-swimmer grenades
Targets: Range support vessel, high performance boats, remote controlled high speed targets (Figure A-5 and Figure A-6) towing surface targets
Duration: Up to 3 hours</td><td>Location:
Mariana Islands Training and Testing Study Area; Mariana Islands Range Complex</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Vessel noise, aircraft noise, weapons firing noise, underwater explosion (E3)
Energy: None
Physical Disturbance and Strike: Vessel and in-water device strike, military expended material strike (projectile, target),
Entanglement: None
Ingestion: Small-caliber projectiles, casings, target fragments</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">Small-caliber projectiles
Target fragments
Casings, grenade fragments</td></tr>
<tr><td>Assumptions used for Analysis</td><td colspan="2">Majority of events will occur proximate to NAVBASE Guam including during times of transit in and out of port, as well as during major training events.</td></tr>
</table>

Figure A-4: "Killer Tomato" Stationary Floating Target

Figure A-5: QST-35 Seaborne Powered Target

Figure A-6: High Speed Maneuvering Surface Target

A.1.5 ANTI-SUBMARINE WARFARE TRAINING

Anti-submarine warfare involves helicopter and maritime patrol aircraft, ships, and submarines. These units operate alone or in combination, in operations to locate, track, and neutralize submarines. Controlling the undersea battlespace is a unique naval capability and a vital aspect of sea control. Undersea battlespace dominance requires proficiency in anti-submarine warfare. Every deploying strike group and individual surface combatant must possess this capability.

Various types of active and passive sonar are used by the Navy to determine water depth, locate mines, and identify, track, and target submarines. Passive sonar "listens" for sound waves by using underwater microphones, called hydrophones, which receive, amplify, and process underwater sounds. No sound is introduced into the water when using passive sonar. Passive sonar can indicate the presence, character, and movement of submarines. However, passive sonar provides only a bearing (direction) to a sound-emitting source; it does not provide an accurate range (distance) to the source. Active sonar is needed to locate objects because active sonar provides both bearing and range to the detected contact (such as an enemy submarine). Active sonar is necessary to detect and track submarines that do not emit detectable levels of noise, either because of noise reduction design features or because of the presence of overwhelming background noise levels.

The Navy's anti-submarine warfare training plan, including the use of active sonar in at-sea training scenarios, includes multiple levels of training. Individual-level anti-submarine warfare training addresses basic skills such as detection and classification of contacts, distinguishing discrete acoustic signatures including those of ships, submarines, and marine life, and identifying the characteristics, functions, and effects of controlled jamming and evasion devices.

More advanced, integrated anti-submarine warfare training exercises involving active sonar is conducted in coordinated, at-sea operations during multi-dimensional training events involving submarines, ships, aircraft, and helicopters. This training integrates the full anti-submarine warfare continuum from detecting and tracking a submarine to attacking a target using either exercise torpedoes or simulated weapons. Training events include detection and tracking exercises against "enemy" submarine contacts; torpedo employment exercises against the target; and exercising command and control tasks in a multi-dimensional battlespace.

A.1.5.1 Tracking Exercise – Helicopter

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Anti-Submarine Warfare</td></tr>
<tr><td>Tracking Exercise – Helicopter</td><td colspan="2">Helicopter crews search, track, and detect submarines.</td></tr>
<tr><td>Long Description</td><td colspan="2">This exercise involves helicopters using sonobuoys and dipping sonar to search for, detect, classify, localize, and track a simulated threat submarine with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine.
Sonobuoys are typically employed by a helicopter operating at altitudes below 3,000 feet (914 meters). Both passive and active sonobuoys are employed.
The dipping sonar is employed from an altitude of about 50 feet (15 meters) after the search area has been narrowed based on the sonobuoy search. Both passive and active sonar are employed.
The anti-submarine warfare target used for this exercise will likely be an Expendable Mobile Anti-submarine Warfare Training Target, a MK-30 recoverable exercise target or a live submarine if available. This exercise may involve a single aircraft, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and vessels, including a major range event.
The tracking exercise becomes a torpedo exercise when the helicopter launches an exercise torpedo.
The exercise torpedo is recovered by a special recovery helicopter or small craft. The preferred range for this exercise is an instrumented range, but it may be conducted in other operating areas depending on training requirements and available assets.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Helicopters, surface vessels
Systems: Mid-frequency helicopter dipping sonar, sonobuoys
Ordnance/Munitions: Reusable exercise torpedoes (non-explosive)
Targets: MK-39 Expendable Mobile Anti-Submarine Warfare Training Target or MK-30 recoverable target, or live submarine
Duration: 2–4 hours</td><td>Location:
Mariana Islands Training and Testing Study Area > 3 nm from land;
Transit Corridor</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Helicopter dipping sonar (MF4), sonobuoy (MF5), aircraft noise, vessel noise
Energy: None
Physical Disturbance and Strike: Military expended material strike, aircraft strike (birds only), vessel and in-water device strike, seafloor devices (Portable Underwater Tracking Range)
Entanglement: Parachutes
Ingestion: Parachutes</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">One Expendable Mobile Anti-Submarine Warfare Training Target
If target is air-dropped, one parachute per target
Up to 20 sonobuoys per event (one parachute for each sonobuoy)
Torpedo accessories (ballast weights, parachutes)
Anchor ballast for tracking range transponders</td></tr>
<tr><td>Assumptions used for Analysis</td><td colspan="2">Only Reusable Exercise Torpedoes used for this event. Tracking exercise can occur in all locations, torpedo exercise will <u>not</u> occur in Transit Corridor. Submarines may provide service as the target.</td></tr>
</table>

A.1.5.2 Torpedo Exercise – Helicopter

Activity Name	**Activity Description**	
Anti-Submarine Warfare		
Torpedo Exercise – Helicopter	Helicopter crews search, track, and detect submarines. Exercise torpedoes may be used during this event.	
Long Description	This exercise involves helicopters using sonobuoys and dipping sonar to search for, detect, classify, localize, and track a simulated threat submarine with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine. The exercise may be conducted on a portable underwater tracking range. Sonobuoys are typically employed by a helicopter operating at altitudes below 3,000 feet (914 meters). Both passive and active sonobuoys are employed. The dipping sonar is employed from an altitude of about 50 feet (15 meters) after the search area has been narrowed based on the sonobuoy search. Both passive and active sonar are employed. The anti-submarine warfare target used for this exercise will likely be an Expendable Mobile Anti-submarine Warfare Training Target, a MK-30 recoverable exercise target or a live submarine if available. This exercise may involve a single aircraft, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and vessels, including a major range event. The tracking exercise becomes a torpedo exercise when the helicopter launches an exercise torpedo. The exercise torpedo is recovered by a special recovery helicopter or small craft. The preferred range for this exercise is an instrumented range, but it may be conducted in other operating areas depending on training requirements and available assets.	
Information Typical to the Event	**Platform:** Helicopters, surface vessels **Systems:** Mid-frequency helicopter dipping sonar, sonobuoys; tracking range transponders **Ordnance/Munitions:** Exercise torpedoes (non-explosive) **Targets:** MK-39 Expendable Mobile Anti-Submarine Warfare Training Target or MK-30 recoverable target, or live submarine **Duration:** 2–4 hours	**Location:** Mariana Islands Training and Testing Study Area > 3 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Helicopter dipping sonar (MF4), sonobuoy (MF5), mid-frequency acoustic countermeasure (ASW4), lightweight torpedo [TORP1]), aircraft noise, vessel noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike, aircraft strike (birds only), vessel and in-water device strike, seafloor devices (Portable Underwater Tracking Range) **Entanglement:** Parachutes **Ingestion:** Parachutes	
Detailed Military Expended Material Information	One Expendable Mobile Anti-Submarine Warfare Training Target If target is air-dropped, one parachute per target Up to 20 sonobuoys per event (one parachute for each sonobuoy) Torpedo accessories (ballast weights, parachutes) Anchor ballast weight for tracking range transponders	
Assumptions used for Analysis	Submarines may provide service as the target.	

A.1.5.3 Tracking Exercise – Maritime Patrol Aircraft Extended Echo Ranging Sonobuoys

Activity Name	**Activity Description**
Anti-Submarine Warfare	
Tracking Exercise – Maritime Patrol Aircraft Extended Echo Ranging Sonobuoys	Maritime patrol aircraft crews search, detect and track submarines using explosive source sonobuoys or multistatic active coherent system.
Long Description	This exercise involves fixed-wing maritime patrol aircraft employing Improved Extended Echo Ranging and Multistatic Active Coherent sonobuoy systems to search for, detect, classify, localize, and track a simulated threat submarine with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine. The Improved Extended Echo Ranging events use the SSQ-110A sonobuoy as an impulsive source, while the Multistatic Active Coherent events utilize the SSQ-125 sonobuoy as a tonal source. Each exercise would include the use of approximately 10 SSQ-110A or SSQ-125 sonobuoys. The anti-submarine warfare target used for this exercise may be a MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, a MK-30 target, or a live submarine. This exercise may involve a single aircraft, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and ships, including a major range event.
Information Typical to the Event	**Platform:** Maritime Patrol Aircraft **Systems:** Improved Extended Echo Ranging and Multistatic Active Coherent sonobuoy systems **Ordnance/Munitions:** None **Targets:** MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, a MK-30 recoverable target, or a live submarine **Duration:** 2–8 hours **Location:** Mariana Islands Training and Testing Study Area > 3 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Sonobuoy (ASW2), underwater explosives (E4), aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only), military expended material strike, seafloor devices (Portable Underwater Tracking Range) **Entanglement:** Parachutes **Ingestion:** Parachutes, Sonobuoy fragments
Detailed Military Expended Material Information	One Expendable Mobile Anti-Submarine Warfare Training Target (MK-39); MK-30 are recovered. Expended sonobuoys with parachutes Anchor ballast for tracking range transponders
Assumptions used for Analysis	If target is air-dropped, one parachute per target.

A.1.5.4 Tracking Exercise – Maritime Patrol Aircraft

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Anti-Submarine Warfare</td></tr>
<tr><td>Tracking Exercise – Maritime Patrol Aircraft</td><td colspan="2">Maritime patrol aircraft crews search, detect, and track submarines. Recoverable air launched torpedoes may be employed against submarine targets.</td></tr>
<tr><td>Long Description</td><td colspan="2">This exercise involves fixed-wing maritime patrol aircraft employing sonobuoys to search for, detect, classify, localize, and track a simulated threat submarine with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine.
Sonobuoys are typically employed by a maritime patrol aircraft operating at altitudes below 3,000 feet (914 meters), however, sonobuoys may be released at higher altitudes. Sonobuoys are deployed in specific patterns based on the expected threat submarine and specific water conditions. Depending on these two factors, these patterns will cover many different size areas. Both passive and active sonobuoys are employed. For certain sonobuoys, tactical parameters of use may be classified. The anti-submarine warfare target used for this exercise may be a MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, a MK-30 target, or a live submarine. This exercise may involve a single aircraft, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and vessels, including a major range event.
The tracking exercise becomes a torpedo exercise when the aircraft launches an exercise torpedo.
The exercise torpedo is recovered by helicopter or small craft. The preferred range for this exercise is an instrumented underwater range, but it may be conducted in other operating areas depending on training requirements and available assets.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Fixed-wing aircraft (Maritime Patrol Aircraft [manned or unmanned]), surface combatant or small vessels
Systems: Sonobuoys
Ordnance/Munitions: Exercise torpedoes (non-explosive)
Targets: MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, a MK-30 recoverable target, or a live submarine
Duration: 2–8 hours</td><td>Location:
Mariana Islands Training and Testing Study Area > 3 nm from land</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Sonobuoys (MF5),vessel noise, aircraft noise
Energy: None
Physical Disturbance and Strike: Aircraft strike (birds only), vessel and in-water device strike, military expended material strike, seafloor devices (Portable Underwater Tracking Range)
Entanglement: Parachutes
Ingestion: Parachutes</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">One Expendable Mobile Anti-Submarine Warfare Training Target (MK-39)
Torpedo accessories (ballast weights, parachutes) from reusable exercise torpedoes
Expended sonobuoys with parachutes
Anchor ballast for tracking range transponders</td></tr>
<tr><td>Assumptions used for Analysis</td><td colspan="2">Submarine may provide service as the target.
If target is air-dropped, one parachute per target.</td></tr>
</table>

A.1.5.5 Torpedo Exercise – Maritime Patrol Aircraft

Activity Name	Activity Description
Anti-Submarine Warfare	
Torpedo Exercise – Maritime Patrol Aircraft	Maritime patrol aircraft crews search, detect, and track submarines. Recoverable air launched torpedoes may be employed against submarine targets.
Long Description	This exercise involves fixed-wing maritime patrol aircraft employing sonobuoys to search for, detect, classify, localize, and track a simulated threat submarine with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine. The exercise may be conducted on a portable underwater tracking range. Sonobuoys are typically employed by a maritime patrol aircraft operating at altitudes below 3,000 feet (914 meters), however, sonobuoys may be released at higher altitudes. Sonobuoys are deployed in specific patterns based on the expected threat submarine and specific water conditions. Depending on these two factors, these patterns will cover many different size areas. Both passive and active sonobuoys are employed. For certain sonobuoys, tactical parameters of use may be classified. The anti-submarine warfare target used for this exercise may be a MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, a MK-30 target, or a live submarine. This exercise may involve a single aircraft, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft and vessels, including a major range event. The tracking exercise becomes a torpedo exercise when the aircraft launches an exercise torpedo. The exercise torpedo is recovered by helicopter or small craft. The preferred range for this exercise is an instrumented underwater range, but it may be conducted in other operating areas depending on training requirements and available assets.
Information Typical to the Event	**Platform:** Fixed-wing aircraft (Maritime Patrol Aircraft [manned or unmanned]), surface combatant or small vessels **Systems:** Sonobuoys; tracking range transponders **Ordnance/Munitions:** Exercise torpedoes (non-explosive) **Targets:** MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, a MK-30 recoverable target, or a live submarine **Duration:** 2–8 hours **Location:** Mariana Islands Training and Testing Study Area > 3 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Sonobuoys (MF5), lightweight torpedo (TORP1]), vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only), vessel and in-water device strike, military expended material strike, seafloor devices (Portable Underwater Tracking Range) **Entanglement:** Parachutes **Ingestion:** Parachutes
Detailed Military Expended Material Information	MK-30 are recovered. Torpedo accessories (ballast weights, parachutes) from exercise torpedoes Expended sonobuoys with parachutes Anchor ballast for tracking range transponders
Assumptions used for Analysis	Submarine may provide service as the target. If target is air-dropped, one parachute per target.

A.1.5.6 Tracking Exercise – Surface

Activity Name	Activity Description	
Anti-Submarine Warfare		
Tracking Exercise – Surface	Surface ship crews search, track, and detect submarines.	
Long Description	Surface ships search, detect, and track threat submarines to determine a firing position to launch a torpedo and attack the submarine. A surface vessel operates at slow speeds while employing hull mounted and/or towed array sonar. Passive or active sonar is employed depending on the type of threat submarine, the tactical situation, and environmental conditions. The target for this exercise is a MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, MK-30 Recoverable Training Target, or live submarine. This exercise may involve a single ship, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft, ships, and submarines, including a major range event. The tracking exercise becomes a torpedo exercise when the ship launches an exercise torpedo. The exercise torpedo is recovered by helicopter or small craft. The preferred range for this exercise is an instrumented underwater range, but it may be conducted in other operating areas depending on training requirements and available assets.	
Information Typical to the Event	**Platform:** Surface vessels **Systems:** Mid-frequency sonar, Nixie (countermeasure system) **Ordnance/Munitions:** Reusable exercise torpedoes (non-explosive torpedo exercise only) **Targets:** Submarine MK-30 or MK-39 Expendable Mobile Anti-Submarine Warfare Training Target **Duration:** 2–4 hours	**Location:** Mariana Islands Training and Testing Study Area > 3 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency acoustic countermeasure (ASW3), high-frequency sonar (HF6), hull mounted sonar (MF1, MF2, MF11), high duty cycle variable depth sonar (MF12), vessel noise **Energy:** None **Physical Disturbance and Strike:** Vessel and in-water device strike; military expended material strike, seafloor devices (Portable Underwater Tracking Range) **Entanglement:** None **Ingestion:** Torpedo accessories, Target fragments	
Detailed Military Expended Material Information	MK-39 Expendable Mobile Anti-Submarine Warfare Training Target Torpedo accessories (ballast weights) from reusable exercise torpedoes Anchor ballast for tracking range transponders	
Assumptions used for Analysis	Submarines may provide service as the target except for torpedo exercise events. Torpedoes are recovered.	

A.1.5.7 Torpedo Exercise – Surface

Activity Name	**Activity Description**	
Anti-Submarine Warfare		
Torpedo Exercise – Surface	Surface ship crews search, track, and detect submarines. Exercise torpedoes may be used during this event.	
Long Description	Surface ships search, detect, and track threat submarines to determine a firing position to launch a torpedo and attack the submarine. The exercise may be conducted on a portable underwater tracking range. A surface vessel operates at slow speeds while employing hull mounted and/or towed array sonar. Passive or active sonar is employed depending on the type of threat submarine, the tactical situation, and environmental conditions. The target for this exercise is a MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, MK-30 Recoverable Training Target, or live submarine. This exercise may involve a single ship, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft, ships, and submarines, including a major range event. The tracking exercise becomes a torpedo exercise when the ship launches an exercise torpedo. The exercise torpedo is recovered by helicopter or small craft. The preferred range for this exercise is an instrumented underwater range, but it may be conducted in other operating areas depending on training requirements and available assets.	
Information Typical to the Event	**Platform:** Surface vessels **Systems:** Mid-frequency sonar, Nixie (countermeasure system); tracking range transponders **Ordnance/Munitions:** Exercise torpedoes (non-explosive torpedo exercise only) **Targets:** Submarine MK-30 or MK-39 Expendable Mobile Anti-Submarine Warfare Training Target **Duration:** 2–4 hours	**Location:** Mariana Islands Training and Testing Study Area > 3 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency acoustic countermeasure (ASW3), high-frequency sonar (HF6), hull mounted sonar (MF1, MF2, MF11), high duty cycle variable depth sonar (MF12), lightweight torpedo (TORP1), vessel noise **Energy:** None **Physical Disturbance and Strike:** Vessel and in-water device strike; military expended material strike, seafloor devices (Portable Underwater Tracking Range) **Entanglement:** None **Ingestion:** Torpedo accessories, Target fragments	
Detailed Military Expended Material Information	MK-39 Expendable Mobile Anti-Submarine Warfare Training Target Torpedo accessories (ballast weights) from exercise torpedoes Anchor ballast for tracking range transponders	
Assumptions used for Analysis	Submarines may provide service as the target except for torpedo exercise events. Torpedoes are recovered.	

A.1.5.8 Tracking Exercise – Submarine

Activity Name	**Activity Description**	
Anti-Submarine Warfare		
Tracking Exercise – Submarine	Submarine crews search, track, and detect submarines and surface ships.	
Long Description	The anti-submarine warfare tracking/torpedo exercise-submarine involves a submarine employing hull mounted and/or towed array sonar against an anti-submarine warfare target such as a MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, a MK-30, or another submarine. During this event, passive sonar is used almost exclusively; active sonar use is restricted because it would reveal the tracking submarine's presence to the target submarine. The preferred type of range for this exercise is an instrumented underwater training range with the capability to track the locations of submarines and targets, to enhance the after-action learning component of the training. This exercise may involve a single submarine, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft, ships, and submarines, including a major range event.	
Information Typical to the Event	**Platform:** Submarines, support craft **Systems:** Mid-frequency (primarily passive) and high-frequency sonar **Ordnance/Munitions:** None **Targets:** Submarine MK-30, MK-39 Expendable Mobile Anti-Submarine Warfare Training Target **Duration:** 8 hours	**Location:** Mariana Islands Training and Testing Study Area > 3 nm from land, Transit Corridor
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency acoustic countermeasure (ASW4), hull-mounted sonar (MF3), high-frequency sonar (HF1, HF6), vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel and in-water device strike, air strike (birds only), seafloor devices (Portable Underwater Tracking Range) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	Anchor ballast for tracking range transponders	
Assumptions used for Analysis	Tracking exercise can occur in all locations > 3 nm from land in Mariana Islands.	

A.1.5.9 Torpedo Exercise – Submarine

Activity Name	**Activity Description**
Anti-Submarine Warfare	
Torpedo Exercise – Submarine	Submarine crews search, track, and detect submarines and surface ships. Exercise torpedoes may be used during this event.
Long Description	The anti-submarine warfare tracking/torpedo exercise-submarine involves a submarine employing hull mounted and/or towed array sonar against an anti-submarine warfare target such as a MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, a MK-30, or another submarine. During this event, passive sonar is used almost exclusively; active sonar use is restricted because it would reveal the tracking submarine's presence to the target submarine. The preferred type of range for this exercise is an instrumented underwater training range with the capability to track the locations of submarines and targets, to enhance the after-action learning component of the training. This exercise may involve a single submarine, or be undertaken in the context of a coordinated larger exercise involving multiple aircraft, ships, and submarines, including a major range event. The tracking exercise becomes a torpedo exercise when the submarine launches an exercise torpedo. The exercise torpedo is recovered by helicopter or small craft. The preferred range for this exercise is an instrumented underwater range, but it may be conducted in other areas depending on training requirements and available assets.
Information Typical to the Event	**Platform:** One or more submarines, support craft **Systems:** Mid-frequency (primarily passive) and high-frequency sonar; tracking range transponders **Ordnance/Munitions:** Exercise torpedoes (non-explosive torpedo exercise only) **Targets:** Submarine MK-30, MK-39 Expendable Mobile Anti-Submarine Warfare Training Target **Duration:** 8 hours **Location:** Mariana Islands Training and Testing Study Area > 3 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency acoustic countermeasure (ASW4), hull-mounted sonar (MF3), high-frequency sonar (HF1, HF6), heavyweight torpedo (TORP2), vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel and in-water device strike, military expended material strike (torpedo accessories), seafloor devices (Portable Underwater Tracking Range) **Entanglement:** Guidance wires **Ingestion:** Torpedo accessories
Detailed Military Expended Material Information	Anchor ballast for tracking range transponders
Assumptions used for Analysis	Torpedoes are recovered. Guidance wire has a low breaking strength and breaks easily. Weights and flex tubing sink rapidly.

A.1.6 MAJOR TRAINING EVENTS

A major training event is comprised of several unit-level range operations conducted by several units operating together while commanded and controlled by a single commander. These exercises typically employ an exercise scenario developed to train and evaluate the Strike Group/Force in required naval tactical tasks. In a major training event, most of the operations and activities being directed and coordinated by the Strike Group commander are identical in nature to the operations conducted in the course in individual, crew, and smaller-unit training events. In a major range event, however, these disparate training tasks are conducted in concert, rather than in isolation.

A.1.6.1 Joint Expeditionary Exercise

Activity Name	**Activity Description**	
Major Training Events		
Joint Expeditionary Exercise	A 10-day exercise which brings different branches of the U.S. military together in a joint environment that includes planning and execution efforts as well as military training activities at sea, in the air, and ashore	
Long Description	Advanced joint level battle group and expeditionary amphibious warfare exercise designed to create a cohesive Carrier and Expeditionary Strike Group. Typically 15 surface ships, amphibious assault craft, helicopters, maritime patrol aircraft, strike fighter aircraft, two submarines, and various unmanned vehicles. More than 8,000 personnel may participate and could include the combined assets of a Carrier Strike Group and Expeditionary Strike Group, Marine Expeditionary Units, Army Infantry Units, and Air Force aircraft.	
Information Typical to the Event	**Platform:** Surface vessels, Fixed-wing aircraft, Helicopters, Unmanned vehicles, Submarines **Systems:** Anti-submarine warfare systems, anti-surface warfare and anti-air warfare gun and missile systems. **Ordnance/Munitions:** Numerous gun rounds, bombs, and missiles, all captured in specific events **Targets:** All surface, air, and anti-submarine warfare targets (e.g., MK-39 Expendable Mobile Anti-submarine Warfare Training Targets) **Duration:** 10 days	**Location:** Mariana Islands Training and Testing Study Area; Mariana Islands Range Complex
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency sonar (e.g., MF1, MF2, MF3, MF4, MF5, MF12, ASW2, ASW3), underwater explosions (e.g.,E4), vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike, vessel and in-water device strike, aircraft strike (birds only) **Entanglement:** Parachutes **Ingestion:** Parachutes, countermeasures, sonobuoy fragments	
Detailed Military Expended Material Information	One MK-39 Expendable Mobile Anti-submarine Warfare Training Targets Air deployed sonobuoy will have a parachute. Expended countermeasures	
Assumptions used for Analysis	All military expended materials, ordnance, explosives, and sonar use is included in individual events.	

A.1.6.2 Joint Multi-Strike Group Exercise

Activity Name	Activity Description
Major Training Events	
Joint Multi-Strike Group Exercise	A 10-day Joint exercise in which up to three carrier strike groups would conduct training exercises simultaneously.
Long Description	The Joint Multi-Strike Group Exercise demonstrates the Navy's ability to operate a large naval force of up to three Carrier Strike Groups in coordination with other Services. In addition to this joint warfare demonstration, it also fulfills the Navy's requirement to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. The exercise would involve Joint assets engaging in a "free play" battle scenario, with U.S. forces pitted against a replicated opposition force. The exercise provides realistic in-theater training.
Information Typical to the Event	**Platform:** Multiple surface combatant vessels, Fixed-wing aircraft, Rotary-wing aircraft, unmanned vehicles, and submarines **Systems:** Anti-Submarine Warfare systems, Anti-Surface Warfare and Anti-Air Warfare gun and missile systems **Ordnance/Munitions:** Numerous gun rounds, bombs, and missiles, all captured in specific events **Targets:** MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, MK-30 Recoverable Training Target, submarine **Duration:** 10 days **Location:** Mariana Islands Training and Testing Study Area > 12 nm from land; Farallon de Medinilla
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency sonar (e.g., MF1, MF2, MF3, MF4, MF5, MF11, MF12, ASW2, ASW3, ASW4), high-frequency sonar (e.g.,HF1); underwater explosions (e.g., E4), vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike, vessel and in-water device strike, aircraft strike (birds only) **Entanglement:** Parachutes **Ingestion:** Parachutes, sonobuoy fragments
Detailed Military Expended Material Information	Anti-Submarine Warfare target: One MK-39 per event. If target is air-dropped, one parachute per target. Target remnants, chaff, flares Sonobuoys: (one parachute for each sonobuoy) Large-, medium- and small-caliber projectiles, bombs, missiles, rockets Expendable acoustic countermeasures
Assumptions used for Analysis	All military expended materials, ordnance, explosives, and sonar use is included in individual events.

A.1.6.3 Fleet Strike Group Exercise

Activity Name	Activity Description
Major Training Events	
Fleet Strike Group Exercise	A 7-day exercise focused on sustainment training for the forward deployed Carrier Strike Group which integrates joint training activities with the U.S. Air Force and U.S. Marine Corps. The exercise focuses on integrated joint training among U.S. military forces in the maritime environment with an ASW threat.
Long Description	The Fleet Strike Group Exercise is a one week event focused on sustainment training for the forward deployed Carrier Strike Group and may integrate joint operations with the U.S. Air Force and U.S. Marine Corps in the Western Pacific. The exercise focuses on integrated joint training among U.S. military forces in the maritime environment with an ASW threat; enabling real-world proficiency in detecting, locating, tracking and engaging units at sea, in the air, and on land, in response to a range of mission areas.
Information Typical to the Event	**Platform:** Surface ships, aircraft, submarines **Systems:** Anti-Submarine Warfare systems, Anti-Surface Warfare and Anti-Air Warfare gun and missile systems **Ordnance/Munitions:** Numerous gun rounds, bombs, and missiles, all captured in specific events **Targets:** MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, MK-30 Recoverable Training Target, submarine **Duration:** 7 days **Location:** Mariana Islands Training and Testing Study Area >12 nm from land; Farallon de Medinilla
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency sonar (e.g., MF1, MF2, MF3, MF4, MF5, MF11, MF12, ASW2, ASW3, ASW4), high-frequency sonar (e.g., HF1); underwater explosions (e.g.,E4), vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike, vessel and in-water device strike, aircraft strike (birds only) **Entanglement:** Parachutes **Ingestion:** Parachutes, sonobuoy fragments
Detailed Military Expended Material Information	Anti-Submarine Warfare target: One MK-39 or MK-30 target (MK-30 is recovered and reused, MK-39 is not) per event. If target is air-dropped, one parachute per target. Parachutes, sonobuoy fragments Sonobuoys: (one parachute for each sonobuoy) Large-, medium-, and small-caliber projectiles, bombs, missiles, rockets Expendable acoustic countermeasures
Assumptions used for Analysis	All military expended material, ordnance, explosives, and sonar use is included in individual events.

A.1.6.4 Integrated Anti-Submarine Warfare Exercise

Activity Name	Activity Description	
Major Training Events		
Integrated Anti-Submarine Warfare Exercise	A 5-day exercise with multiple ships, aircraft and submarines integrating the use of their sensors, including sonobuoys, to search, detect, and track threat submarines.	
Long Description	This is a 5-day Anti-Submarine Warfare (ASW) exercise conducted by the forward deployed Navy Strike Groups to sustain and assess their ASW proficiency while located in the Seventh Fleet area of operations. The exercise is designed to assess the Strike Groups' ability to conduct ASW in the most realistic environment, against the level of threat expected, in order to effect changes to both training and capabilities (e.g., equipment, tactics, and changes to size and composition) of U.S. Navy Strike Groups. The Strike Group receives significant sustainment training value in ASW and other warfare areas, as training is inherent in all at-sea exercises.	
Information Typical to the Event	**Platform:** Surface vessels, fixed and rotary-wing aircraft, submarines, unmanned vehicles **Systems:** Hull mounted, towed array, dipping sonar, mid-frequency sonar, sonobuoys **Ordnance/Munitions:** Sonobuoys **Targets:** Expendable mobile anti-submarine warfare training targets **Duration:** 7 days	**Location:** Mariana Islands Training and Testing Study Area > 3 nm from land; Farallon de Medinilla
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency sonar (e.g., MF1, MF2, MF3, MF4, MF5, MF11, MF12, ASW3, ASW4), high-frequency sonar (e.g., HF1); vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike, vessel and in-water device strike, aircraft strike (birds only) **Entanglement:** Parachutes **Ingestion:** Parachutes, sonobuoy fragments	
Detailed Military Expended Material Information	Parachutes, sonobuoy fragments, expended countermeasures	
Assumptions used for Analysis	Air deployed sonobuoy will have a parachute.	

A.1.6.5 Ship Squadron Anti-Submarine Warfare Exercise

Activity Name	**Activity Description**	
Major Training Events		
Integrated Anti-Submarine Warfare Exercise	A 5-day exercise where the overall objective is to sustain and assess surface ship Anti-Submarine Warfare (ASW) readiness and effectiveness. The exercise typically involves multiple ships, submarines, and aircraft in several coordinated events, maximizing opportunities to collect high-quality data.	
Long Description	The Ship Squadron ASW Exercise overall objective is to sustain and assess surface ship ASW readiness and effectiveness. The exercise typically involves multiple ships, submarines, and aircraft in several coordinated events over a period of a week or less. Maximizing opportunities to collect high-quality data to support quantitative analysis and assessment of operations is an additional goal of this training.	
Information Typical to the Event	**Platform:** Surface vessels, fixed and rotary-wing aircraft, submarines, unmanned vehicles **Systems:** Hull mounted, towed array, dipping sonar, mid-frequency sonar, Sonobuoys **Ordnance/Munitions:** Sonobuoys **Targets:** Expendable mobile anti-submarine warfare training targets **Duration:** 7 days	**Location:** Mariana Islands Training and Testing Study Area > 3 nm from land; Farallon de Medinilla
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency sonar (e.g., MF1, MF2, MF3, MF4, MF5, MF11, MF12, ASW3, ASW4), high-frequency sonar (e.g., HF1); vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike, vessel and in-water device strike, aircraft strike (birds only) **Entanglement:** Parachutes **Ingestion:** Parachutes, sonobuoy fragments	
Detailed Military Expended Material Information	Parachutes, sonobuoy fragments, expended countermeasures	
Assumptions used for Analysis	Air deployed sonobuoy will have a parachute.	

A.1.6.6 Marine Air Ground Task Force Exercise (Amphibious) – Battalion

Activity Name	Activity Description	
Major Training Events		
Marine Air Ground Task Force Exercise (Amphibious) – Battalion	A 10-day exercise which conducts over the horizon, ship to objective maneuver for the elements of the Expeditionary Strike Group and the Amphibious Marine Air Ground Task Force. The exercise utilizes all elements of the Marine Air Ground Task Force (Amphibious), conducting training activities ashore with logistic support of the Expeditionary Strike Group and conducting amphibious landings.	
Long Description	This exercise may last up to 10 days and conducts over the horizon, ship to objective maneuver of the elements of the Expeditionary Strike Group and the Amphibious Marine Air Ground Task Force. The exercise utilizes all elements of the task force to secure the battlespace (air, land, and sea), maneuver to and seize the objective, and conduct self-sustaining operations ashore with continual logistic support. Tinian is the primary training area for this exercise; however elements of the exercise may be rehearsed nearshore and on Guam. The landing force is supported by all of the battalions assigned to a Marine Expeditionary Unit.	
Information Typical to the Event	**Platform:** Rotary-wing aircraft, fixed-wing, aircraft, amphibious ships and craft, combatant vessels, submarine **Systems:** Mid-frequency and high-frequency sonar, dipping sonar, high-frequency acoustic modems and tracking pingers, sonobuoys **Ordnance/Munitions:** blanks, Simunitions **Targets:** MK-30, MK-39 Expendable Mobile Anti-submarine Warfare Training Targets, submarine **Duration:** 10 days	**Location:** Mariana Islands Training and Testing Study Area to nearshore; Mariana Islands Range Complex; Tinian; Guam; Rota; Saipan; Farallon de Medinilla
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency sonar (e.g., MF1, MF2, MF3, MF4, MF12, ASW3), high-frequency sonar (e.g., HF1); vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, aircraft strike **Entanglement:** Parachutes **Ingestion:** Parachutes	
Detailed Military Expended Material	One MK-39 or MK-30 target (MK-30 is recovered and reused, MK-39 is not) If target is air-dropped, one parachute per target. Sonobuoys: (one parachute for each sonobuoy)	
Assumptions Used for Analysis	All MEM, ordnance, explosives, and sonar use is included in individual events.	

A.1.6.7 Special Purpose Marine Air Ground Task Force Exercise

Activity Name	Activity Description	
Major Training Events		
Special Purpose Marine Air Ground Task Force Exercise	A 10-day exercise similar to Marine Air Ground Task Force (Amphibious) – Battalion, but task organized to conduct a specific mission (e.g., Humanitarian Assistance, Disaster Relief, Noncombatant Evacuation Operations).	
Long Description	Special Purpose Marine Air Ground Task Force, operating in conjunction with Navy ships and aircraft, typically conduct humanitarian and disaster relief, or evacuation of noncombatants from foreign countries to safe havens or back to the United States when their lives are endangered by war, civil unrest, or natural disaster. Normally, there is no opposition from the host country; however Marine Corps Special Purpose Marine Air Ground Task Force or Marine Expeditionary Unit (Special Operations Capable) normally trains for evacuation under a circumstance that requires the use of force in a hostile environment. Much like a raid, the event involves the rapid introduction of forces, the evacuation of noncombatants, and a planned withdrawal. The activity is conducted during day or night. Guam is the primary training are for this exercise.	
Information Typical to the Event	**Platform:** Multiple rotary-wing aircraft, fixed-wing aircraft, amphibious vessels and craft **Systems:** None **Ordnance/Munitions:** Blanks, Simunitions **Targets:** None **Duration:** 10 days	**Location:** Mariana Islands Training and Testing Study Area to nearshore; Mariana Islands Range Complex; Tinian; Guam; Rota; Saipan
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Submarine strike, vessel strike, aircraft strike **Entanglement:** Parachutes **Ingestion:** Parachutes	
Detailed Military Expended Material	Parachutes associated with insertion of forces, equipment.	
Assumptions Used for Analysis	All MEM is included in individual events.	

A.1.6.8 Urban Warfare Exercise

Activity Name	Activity Description	
Major Training Events		
Urban Warfare Exercise	A 7–21 day Marine Expeditionary Unit integration level exercise conducted over a period of weeks. Enhances the skills needed for military training activities in an urban environment.	
Long Description	A Marine Expeditionary Unit integration level exercise conducted over a period of weeks. Personnel enhance the skills needed for military operations in an urban environment. Events typically take place on Guam and utilize Finegayan, Andersen South, Barrigada Housing, and Northwest Field. Urban Warfare Exercise has been conducted in Saipan as part of the Joint Expeditionary Exercise. Urban Warfare Exercise on Tinian and Rota is also possible	
Information Typical to the Event	**Platform:** Multiple rotary-wing aircraft, fixed-wing aircraft, unmanned aerial vehicles **Systems:** None **Ordnance/Munitions:** Blanks, Simunitions **Targets:** None **Duration:** 7–21 days	**Location:** Mariana Islands Range Complex; Tinian; Guam; Rota; Saipan
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	Land event	

A.1.7 ELECTRONIC WARFARE TRAINING

Electronic warfare is the mission area of naval warfare that aims to control use of the electromagnetic spectrum and to deny its use by an adversary. Typical electronic warfare activities include threat avoidance training, signals analysis for intelligence purposes, and use of airborne and surface electronic jamming devices to defeat tracking systems.

A.1.7.1 Electronic Warfare Operations

Activity Name	Activity Description	
Electronic Warfare		
Electronic Warfare Operations **(EW OPS)**	Aircraft, surface ship, and submarine crews attempt to control portions of the electromagnetic spectrum used by enemy systems to degrade or deny the enemy's ability to take defensive actions.	
Long Description	Aircraft, surface ship, and submarine personnel attempt to control critical portions of the electromagnetic spectrum used by enemy systems to degrade or deny their ability to defend its forces from attack or recognize an emerging threat early enough to take defensive actions. Electronic Warfare Operations can be active or passive, offensive or defensive. Fixed-wing aircraft employ active jamming and deception against enemy search radars to mask the friendly inbound strike aircraft mission. Surface vessels and submarines detect and evaluate enemy electronic signals from enemy aircraft or missile radars, evaluate courses of action concerning the use of passive or active countermeasures, then use vessel maneuvers and either chaff, flares, active electronic countermeasures, or a combination of them to defeat the threat.	
Information Typical to the Event	**Platform:** Fixed and rotary-wing aircraft, Surface combatant vessels **Systems:** None **Ordnance/Munitions:** None **Targets:** Land based fixed/mobile threat emitters **Duration:** 1–2 hours	**Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	All chaff and flares involved in this event are covered under chaff exercise and flare exercises, respectively.	

A.1.7.2 Counter Targeting Flare Exercise – Aircraft

Activity Name	Activity Description	
Electronic Warfare		
Counter Targeting – Flare Exercise (FLAREX) – Aircraft	Fixed-winged aircraft and helicopters crews defend against an attack by deploying flares to disrupt threat infrared (IR) missile guidance systems.	
Long Description	Train fixed-winged aircraft and helicopter crews to deploy flares to disrupt threat infrared missile guidance systems to defend against an attack. Aircraft detect electronic targeting signals from threat radars or missiles or a threat missile plume when it is launched; dispense flares; and immediately maneuver to defeat the threat. This exercise trains aircraft personnel in the use of defensive flares designed to confuse infrared sensors or infrared homing missiles, thereby causing the sensor or missile to lock onto the flares instead of the real aircraft. Typically an aircraft will expend five flares in an exercise while operating above 3,000 feet. Flare exercises are often conducted with chaff exercises, rather than as a stand-alone exercise. Pyrotechnics are used on the range to simulate missile firings.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft, rotary-wing aircraft **Systems:** None **Ordnance/Munitions:** Flares and pyrotechnics **Targets:** None **Duration:** 1–2 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft Noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** Expended components of flares (pistons)	
Detailed Military Expended Material Information	Flares and residuals from pyrotechnics	
Assumptions used for Analysis	Approximately five flares per aircraft	

A.1.7.3 Counter Targeting Chaff Exercise – Ship

Activity Name	Activity Description	
Electronic Warfare		
Counter Targeting Chaff Exercise (CHAFFEX) – Ship	Surface ships defend against an attack by deploying chaff, a radar reflective material, which disrupt threat targeting and missile guidance radars.	
Long Description	Surface vessel crews deploy chaff to disrupt threat targeting and missile guidance radars to defend against an attack. Surface vessel crews detect electronic targeting signals from threat radars or missiles, dispense chaff, and immediately maneuver to defeat the threat. The chaff cloud deceives the inbound missile, and the vessel clears away from the threat. Chaff is a radar reflector material made of thin, narrow, metallic strips cut in various lengths to elicit frequency responses, which deceive enemy radars. Chaff is employed create a target from the chaff that will lure enemy radar and weapons system away from the actual friendly platform. Ships may also train with advanced countermeasure systems, such as the MK 53 Decoy Launching System (Nulka).	
Information Typical to the Event	**Platform:** Surface vessels **Systems:** None **Ordnance/Munitions:** None **Targets:** MK 53 expendable decoys **Duration:** 1.5 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike **Entanglement:** None **Ingestion:** Expended components of chaff (end caps, pistons, chaff)	
Detailed Military Expended Material Information	Chaff canisters Expended components of chaff (end caps, pistons, chaff) MK 53 expendable decoys	
Assumptions used for Analysis	None	

A.1.7.4 Counter Targeting Chaff Exercise – Aircraft

Activity Name	Activity Description	
Electronic Warfare		
Counter Targeting Chaff Exercise (CHAFFEX) – Aircraft	Fixed-winged aircraft and helicopter crews defend against an attack by deploying chaff, a radar reflective material, which disrupt threat targeting and missile guidance radars.	
Long Description	Fixed-winged aircraft and helicopter crews deploy chaff to disrupt threat targeting and missile guidance radars and to defend against an attack. Fixed-winged aircraft and helicopter crews detect electronic targeting signals from threat radars or missiles, dispense chaff, and immediately maneuver to defeat the threat. The chaff cloud deceives the inbound missile and the aircraft clears away from the threat. Chaff is a radar reflector material made of thin, narrow, metallic strips cut in various lengths used to lure an enemy radar and weapons system away from the actual friendly platform.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft, rotary-wing aircraft **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** 1.5 hours	**Location:** Mariana Islands Training and Testing Study Area > 12 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** Expended components of chaff (end caps, pistons, chaff)	
Detailed Military Expended Material Information	Chaff cartridges Plastic end caps Pistons	
Assumptions used for Analysis	Chaff is usually expended while conducting other training activities, such as air combat maneuvering.	

A.1.8 MINE WARFARE TRAINING

Mine warfare training is the naval warfare area involving the detection, avoidance, and neutralization of mines to protect Navy ships and submarines, and offensive mine laying in naval operations. A naval mine is a self-contained explosive device placed in water to destroy ships or submarines. Naval mines are deposited and left in place until triggered by the approach of, or a contact with an enemy ship, or are destroyed or removed. Naval mines can be laid by purpose-built minelayers, other ships, submarines, or airplanes. Mine warfare training includes mine countermeasures exercises and mine laying exercises.

A.1.8.1 Civilian Port Defense

Activity Name	Activity Description
Major Training Events	
Civilian Port Defense	Civilian Port Defense exercises are naval mine warfare activities conducted at various ports and harbors, in support of maritime homeland defense/security.
Long Description	Naval forces provide Mine Warfare capabilities to DHS led event. The three pillars of MIW, Airborne (helicopter), Surface (ships and unmanned vehicles), and Undersea (divers, marine mammals, and unmanned vehicles) mine countermeasures will be brought to bear in order to ensure strategic US ports remain free of mine threats. Various MIW sensors, which utilize active acoustics, will be employed in the detection, classification, and neutralization of mines. Along with traditional MIW techniques, such as helicopter towed mine countermeasures, new technologies (unmanned vehicles) will be utilized. Event locations and scenarios will vary according to DHS strategic goals and evolving world events. Purpose of MITT analysis is to ensure adequate Marine Mammal Protection Act (MMPA) authorizations are in place to support the use of acoustic mine detection sensors. Additional analysis and regulatory engagement will be conducted as appropriate as planning for the actual events begin.
Information Typical to the Event	**Platform:** Surface combatant vessels (e.g., LCS, MCM), small boats, rotary wing aircraft **Systems:** Unmanned underwater and surface vehicles, various mine detection sensors (e.g., AN/AQS-20, AN/AQS-24) **Ordnance/Munitions:** High-explosive charges **Targets:** Temporary mine shapes **Duration:** Multiple days **Location:** Mariana littorals, Mariana Islands Range Complex; Inner and Outer Apra Harbor
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** High-frequency sonar (e.g., HF4); underwater explosions (e.g., E2, E4), vessel noise, aircraft noise **Energy:** Magnetic influence mine sweeping **Physical Disturbance and Strike:** Vessel and in-water device strike, seafloor device (bottom placed mine shapes), aircraft strike (birds only) **Entanglement:** None **Ingestion:** None
Detailed Military Expended Material	None
Assumptions Used for Analysis	Non-permanent mine shapes will be laid in various places on the bottom. Shapes are varied, from about 1 meter circular to about 2.5 meters long by 1 meter wide. They will be recovered using normal assets, with diver involvement.

A.1.8.2 Mine Laying

Activity Name	Activity Description	
Mine Warfare		
Mine Laying	Fixed-winged aircraft and vessel crews drop/launch non explosive mine shapes.	
Long Description	Fixed-winged aircraft or surface or submarine crews lay offensive or defensive mines for a tactical advantage for friendly forces. Crews lay a precise minefield pattern for specific tactical situations. An aircrew typically makes multiple passes in the same flight pattern, and drops one or more training shapes (four shapes total). Training shapes are non-explosive.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft, surface vessels, submarines **Systems:** None **Ordnance/Munitions:** Non-explosive mine shapes, "Quick-strike" mines **Targets:** None **Duration:** 1 hour	**Location:** MIRC Warning Areas
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, vessel noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike (non-explosive mine shapes), vessel strike, and aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	Non-explosive mine shapes	
Assumptions used for Analysis	Similar to non-explosive bombing exercise. Assume mine shapes are not recovered for the analysis.	

A.1.8.3 Mine Neutralization – Explosive Ordnance Disposal (EOD)

Activity Name	Activity Description	
Mine Warfare		
Mine Neutralization – Explosive Ordnance Disposal (EOD)	Personnel disable threat mines. Explosive charges may be used.	
Long Description	Navy divers, typically explosive ordnance disposal personnel, disable threat mines with explosive charges to create a safe channel for friendly vessels to transit. Personnel detect, identify, evaluate, and neutralize mines in the water with an explosive device and may involve detonation of one or more explosive charges typically up to 20 pounds (lb.) of TNT equivalent. These operations are normally conducted during daylight hours for safety reasons.	
Information Typical to the Event	**Platform:** Rotary-wing aircraft, small boats **Systems:** None **Ordnance/Munitions:** Underwater detonation charges **Targets:** Minefields **Duration:** Up to 4 hours	**Location:** Mariana Islands Range Complex mine neutralization sites, 20 lb. net explosive weight (NEW) maximum (Piti site is 10 lb. NEW maximum)
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Under water explosions (e.g., E5, E6), vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, aircraft strike (birds only), seafloor devices **Entanglement:** None **Ingestion:** Target fragments	
Detailed Military Expended Material Information	Target fragments	
Assumptions used for Analysis	Charge placed anywhere in water column, including bottom. Mine shapes will be recovered.	

A.1.8.4 Limpet Mine Neutralization System/Shock Wave Generator

Activity Name	Activity Description	
Mine Warfare (MIW)		
Limpet Mine Neutralization System/Shock Wave Generator	Navy divers place a small charge on a simulated underwater mine.	
Long Description	For shock wave generator training, a metal sheet containing a non-explosive limpet mine is lowered into the water, sometimes from the side of a small vessel, such as an LCM-8 craft. Divers place a single shock wave generator on the mine that is located mid-water column, within water depths of 10–20 feet (3–6 meters). A bag is placed over the mine to catch falling debris.	
Information Typical to the Event	**Platform:** None **Systems:** None **Ordnance/Munitions:** Less than 1 oz. explosive charge **Targets:** Metal sheet with limpet mine **Duration:** 2 hours	**Location:** Mariana littorals; Inner and Outer Apra Harbor
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Less than E1 explosive charge **Energy:** None **Physical Disturbance and Strike:** None **Entanglement:** None **Ingestion:** Mine detonation residue	
Detailed Military Expended Material	Minimal mine detonation residue (most materials are recovered after each event)	
Assumptions Used for Analysis	None	

A.1.8.5 Submarine Mine Exercise

Activity Name	**Activity Description**	
Mine Warfare (MIW)		
Submarine Mine Exercise	Submarine crews practice detecting mines in a designated area.	
Long Description	Submarine crews use active sonar to detect and avoid mines or other underwater hazardous objects, while navigating restricted areas or channels, such as while entering or leaving port. This event trains submarine crews to detect and avoid mines. Training utilizes simulated minefields constructed of moored or bottom mines, or instrumented mines that can record effectiveness of mine detection efforts. In a typical training exercise, submarine crews will use the AN/BQQ-10 high-frequency active sonar to locate and avoid the mine shapes. Each mine avoidance exercise involves one submarine operating the AN/BQQ-10 high-frequency sonar for 6 hours to navigate through the training minefield. During mine warfare exercises submarines will expend several submarine-launched expendable bathythermographs to determine water conditions affecting sonar performance.	
Information Typical to the Event	**Platform:** Submarine **Systems:** High-frequency sonar (navigation/mine detection sonar) **Ordnance/Munitions:** None **Targets:** Mine shapes **Duration:** 6 hours	**Location:** Mariana Islands Training and Testing Study Area; nearshore
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** High-frequency sonar (e.g., HF1) **Energy:** None **Physical Disturbance and Strike:** Vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	None	

A.1.8.6 Airborne Mine Countermeasure – Mine Detection

Activity Name	Activity Description	
Mine Warfare		
Airborne Mine Countermeasure – Mine Detection	Vessel crews and helicopter aircrews detect mines using towed or laser mine detection systems (e.g., AN/AQS-20, Airborne Laser Mine Detection System).	
Long Description	Helicopter crews use towed and airborne devices to detect, locate, and classify potential mines. Towed devices employ active acoustic sources, such as high frequency and side scanning sonar. These devices are similar in function to systems used to map the seafloor or locate submerged structures or items. Airborne devices utilize laser systems to locate mines located below the surface. Devices used include the AN/AQS-20/A, towed minehunting sonar used to detect and classify bottom and floating/moored mines in deep and shallow water, and the Airborne Laser Mine Detection System, developed to detect and classify floating and near-surface, moored mines.	
Information Typical to the Event	**Platform:** Rotary-wing aircraft, Unmanned surface vehicles, Unmanned underwater vehicles **Systems:** Airborne Laser Mine Detection System (AN/AQS-20A, AN/AQS-24A) **Ordnance/Munitions:** None **Targets:** Existing minefields, temporary placed mines, or no targets (training to deploy/operate gear) **Duration:** Typically 1.5 hours, up to 4 hours	**Location:** Mariana Islands Training and Testing Study Area; nearshore
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mine detection sonar (HF4), vessel noise, aircraft noise **Energy:** In-air low energy laser **Physical Disturbance and Strike:** Vessel and in-water device strike, aircraft strike (birds only), seafloor device strike (bottom placed mine shapes) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	Sonar mine detection systems towed from helicopters, vessels, unmanned surface vehicles Use of airborne laser systems to detect mine shapes Laser systems similar to commercial Light Detection And Ranging (LIDAR) systems Mine shapes will be recovered	

A.1.8.7 Mine Countermeasure Exercise – Towed Sonar

Activity Name	Activity Description
Mine Warfare	
Mine Countermeasure Exercise – Towed Sonar	Surface ship crews detect and avoid mines while navigating restricted areas or channels using towed active sonar.
Long Description	Surface vessel crews detect and avoid mines or other underwater hazardous objects while navigating restricted areas or channels using active sonar. Littoral Combat Ship utilizes unmanned surface vehicles and remotely operated vehicles to tow mine detection (hunting) equipment. Systems will operate from shallow zone greater than 40 feet to deep water. Events could be embedded in major training events.
Information Typical to the Event	**Platform:** Surface vessels (e.g., LCS), unmanned surface vehicles, unmanned aerial vehicles **Systems:** AN/AQS-20, remote mine hunting system, AN/AQS-24 **Ordnance/Munitions:** None **Targets:** Minefields, temporary placed mine (training to deploy or operate gear) **Duration:** 1.5–4 hours **Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Sonar and other acoustic sources (HF4), vessel noise, aircraft noise **Energy:** Sub-surface laser imaging **Physical Disturbance and Strike:** Vessel and in-water device strike, seafloor devices, aircraft strike (birds only) **Entanglement:** None **Ingestion:** None
Detailed Military Expended Material Information	None Temporary placed mines will be recovered.
Assumptions used for Analysis	No explosives used. Constraints: Assume system will be operated in areas free of obstructions, and will be towed well above the seafloor. Towed system will be operated in a manner to avoid entanglement and damage. Events will take place in water depths 40 feet and greater. Existing placed mine shapes to be used. Potential for temporary placement of mine shapes.

A.1.8.8 Mine Countermeasure Exercise – Surface Sonar

Activity Name	Activity Description	
Mine Warfare		
Mine Countermeasure Exercise – Surface (SMCMEX) Sonar	Mine countermeasure ship crews detect, locate, identify, and avoid mines while navigating restricted areas or channels using active sonar.	
Long Description	This event trains mine countermeasure ship crews to detect mines for future neutralization or to alert other ships. Training utilizes simulated minefields constructed of moored or bottom mines, or instrumented mines that can record effectiveness of mine detection efforts. Ships will accurately fix their position while navigating through the restricted mine threat area at slow speeds of about 5 to 10 knots or less, while using active sonar to search the area ahead of the ship for moored mines or other hazards of navigation.	
Information Typical to the Event	**Platform:** Surface combatant vessel **Systems:** Sonar (e.g., AN/SQQ-32) **Ordnance/Munitions:** None **Targets:** None **Duration:** The exercise may last as long as 15 hours.	**Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mine detection sonar (HF4), vessel noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.8.9 Mine Neutralization – Remotely Operated Vehicle Sonar

Activity Name	Activity Description	
Mine Warfare		
Mine Neutralization – Remotely Operated Vehicle Sonar	Vessel or helicopter aircrews disable mines using remotely operated underwater vehicles.	
Long Description	Vessel and helicopter crews utilize remotely operated vehicles to neutralize potential mines. Remotely operated vehicles will use sonar and optical systems to locate and target mine shapes. Explosive mine neutralizers may be used during live fire events.	
Information Typical to the Event	**Platform:** Rotary-wing aircraft, surface combatant vessels **Systems:** Acoustic mine targeting system **Ordnance/Munitions:** High-explosive neutralizers **Targets:** Existing minefields, temporary placed mines **Duration:** Typically 1.5 hours, up to 4 hours	**Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mine hunting sonar (HF4), underwater explosions (E4), vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel and in-water device strike, seafloor device strike (bottom placed mine shapes), aircraft strike (birds only) **Entanglement:** Fiber optic cable **Ingestion:** Neutralizer fragments	
Detailed Military Expended Material Information	Neutralizer fragments Fiber optic cables	
Assumptions used for Analysis	Acoustic sources associated with remotely operated vehicle mine neutralization systems do not require quantitative analysis.	

A.1.8.10 Mine Countermeasure – Towed Mine Neutralization

Activity Name	Activity Description	
Mine Warfare		
Mine Countermeasure – Towed Mine Neutralization	Ship crews and helicopter aircrews tow systems (e.g., Organic and Surface Influence Sweep, MK 104/105) through the water that are designed to disable and/or trigger mines.	
Long Description	Naval helicopters and unmanned vessels use towed devices to clear minefields by triggering mines that sense and explode when they detect ships/submarines by engine/propeller sounds or magnetic (steel construction) signature. Towed devices can also employ cable cutters to detach floating moored mines. Training will either be conducted against non-explosive training mine shapes, or, without any mine shapes. A high degree of pilot skill is required in deploying devices, safely towing them at relatively low speeds and altitudes, and then recovering devices. Devices used include the following: Organic Airborne and Surface Influence Sweep (OASIS). The Organic Airborne and Surface Influence Sweep is a towed device that imitates the magnetic and acoustic signatures of naval ships and submarines. MK 105 sled: the MK 105 sled, similar to the Organic Airborne and Surface Influence Sweep, creates a magnetic field used to trigger mines. The MK 105 sled can also be used in conjunction with the MK 103 cable cutter system and the MK 104 acoustic countermeasure. AN/SPU-1/W "Magnetic Orange Pipe": As the name implies, the AN/SPU-1/W is a magnetic pipe that is used to trigger magnetically influenced mines.	
Information Typical to the Event	**Platform:** Surface vessel (e.g., MCM, LCS), unmanned surface vehicle, unmanned underwater vehicles, rotary-wing aircraft **Systems:** None **Ordnance/Munitions:** Cable cutters (MK-103) **Targets:** Existing minefields, temporary placed mines, or no targets (training to deploy/operate gear) **Duration:** Typically 1.5 hours, up to 4 hours	**Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, aircraft noise **Energy:** Electromagnetic influence sweep **Physical Disturbance and Strike:** Vessel and in-water device strike, seafloor device strike (bottom placed mine shapes) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	Mooring blocks	
Assumptions used for Analysis	Towed from helicopters, ships, unmanned surface vehicles and unmanned underwater vehicles. Mechanical sweeping (cable cutting), acoustic, and magnetic influence sweeping Cable cutters utilize an insignificant charge (similar to shotgun shell). Acoustic sweeps generate ship type noise via mechanical system. Towing systems though minefields (or without mines, to train to deploy, tow, and recover). May involve instrumented mines (VIMS).	

A.1.9 NAVAL SPECIAL WARFARE TRAINING

Naval special warfare and other special forces train to conduct military operations in five Special Operations mission areas: unconventional warfare, direct action, special reconnaissance, foreign internal defense, and counterterrorism. Naval special warfare training involves specialized tactics, techniques, and procedures, employed in training events that include: insertion/extraction operations using parachutes rubber boats, or helicopters; boat-to-shore and boat-to-boat gunnery; underwater demolition training; reconnaissance; and small arms training.

A.1.9.1 Personnel Insertion/Extraction

Activity Name	Activity Description	
Naval Special Warfare		
Personnel Insertion/Extraction	Military personnel train for covert insertion and extraction into target areas using helicopters, fixed-wing (insertion only), small boats, and submersibles.	
Long Description	Personnel train to approach or depart an objective area using various transportation methods and tactics. These operations train forces to insert and extract personnel and equipment day or night. Tactics and techniques employed include insertion from aircraft by parachute, by rope, or from low, slow-flying helicopters from which personnel jump into the water. Parachute training is required to be conducted on surveyed drop zones to enhance safety. Insertion and extraction methods also employ small inflatable boats.	
Information Typical to the Event	**Platform:** Fixed and rotary-wing aircraft, small craft, submersibles **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** 2–8 hours	**Location:** Mariana Islands Range Complex; Guam; Tinian; Rota
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Physical disturbance (sea turtle nests) **Entanglement:** Parachutes **Ingestion:** Parachutes	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	None	

A.1.9.2 Parachute Insertion

Activity Name	Activity Description	
Naval Special Warfare		
Parachute Insertion	Military personnel train for covert insertion into target areas using parachutes.	
Long Description	These operations will vary in length depending on the transportation method and systems being used. Target areas are parachute drop zones that may be at sea or on land.	
Information Typical to the Event	**Platform:** Sea, air, land delivery vehicle **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** 2–8 hours	**Location:** Mariana Islands Range Complex parachute drop zones; Guam; Tinian; Rota
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, small craft noise **Energy:** None **Physical Disturbance and Strike:** None **Entanglement:** Parachutes **Ingestion:** Parachutes	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	None	

A.1.9.3 Embassy Reinforcement

Activity Name	Activity Description	
Naval Special Warfare		
Embassy Reinforcement	Special Warfare units train to provide reinforcement of an Embassy under hostile conditions.	
Long Description	Personnel integrate vessel, aircraft and ground assets to reinforce an embassy under assault	
Information Typical to the Event	**Platform:** Small boats, assault craft, helicopters, fixed-wing aircraft, unmanned aerial vehicles **Systems:** None **Ordnance/Munitions:** Blanks, Simunitions **Targets:** None	**Location:** Mariana Islands Range Complex; Guam; Tinian; Rota
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	None	

A.1.9.4 Direct Action (Combat Close Quarters)

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Naval Special Warfare</td></tr>
<tr><td>Direct Action (Combat Close Quarters)</td><td colspan="2">Military personnel training for use of force, breaching doors and obstacles, and in close quarters combat.</td></tr>
<tr><td>Long Description</td><td colspan="2">Special Forces personnel use covert or overt small unit tactics against an enemy force to seize, damage, or destroy a target and/or capture or recover personnel or material. A squad or platoon size force are inserted into and later extracted from a hostile area by helicopter.
Combat Rubber Raiding Craft, or other technique, and then use small-scale offensive actions to attack hostile forces or targets. These offensive actions can include: raids, ambushes, standoff attacks by firing from ground, air, or maritime platforms, designating or illuminating targets for precision-guided munitions, providing support for cover and deception operations, and sabotage.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Small boats, rotor-wing craft
Systems: None
Ordnance/Munitions: Small arms, blanks, Simunitions
Targets: None</td><td>Location:
Mariana Islands Range Complex Combat Close Quarters Sites</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Vessel noise, aircraft noise
Energy: None
Physical Disturbance and Strike: Vessel strike, aircraft strike (birds only), physical disturbance (sea turtle nests)
Entanglement: None
Ingestion: None</td></tr>
<tr><td>Detailed Military Expended Material</td><td colspan="2">None</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="2">None</td></tr>
</table>

A.1.9.5 Direct Action (Breaching)

Activity Name	Activity Description	
Naval Special Warfare		
Direct Action (Breaching)	Military personnel training for use of force, breaching doors and obstacles, and in close quarters combat.	
Long Description	This event is limited to the breaching of doors and obstacles at sites prepared for breaching by small explosive charge. It is an event conducted alone or can be planned with other events.	
Information Typical to the Event	**Platform:** None **Systems:** None **Ordnance/Munitions:** Small explosive charges for breaching doors **Targets:** None	**Location:** Mariana Islands Range Complex Explosive Breaching Sites (e.g., the Breacher House on Naval Base Guam Munitions Site)
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Breach explosive noise **Energy:** None **Physical Disturbance and Strike:** None **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	None	

A.1.9.6 Direct Action (Tactical Air Control Party)

Activity Name	Activity Description	
Naval Special Warfare		
Direct Action (Tactical Air Control Party)	Military personnel train for controlling of combat support aircraft; providing airspace de-confliction and terminal control for Close Air Support.	
Long Description	Tactical Air Control personnel, once at FDM, participate in tactical air control training in conjunction with an Air-to-Ground bombing or missile exercise, They may also employ small arms, grenades, mortars, and crew served weapons in direct action against targets on the island.	
Information Typical to the Event	**Platform:** Small boats, rotor-wing and fixed-wing aircraft **Systems:** None **Ordnance/Munitions:** Small-caliber rounds, explosive grenades and mortars **Targets:** None	**Location:** Farallon de Medinilla
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, vessel noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	None	

A.1.9.7 Underwater Demolition Qualification/Certification

Activity Name	Activity Description	
Naval Special Warfare		
Underwater Demolition Qualification/Certification	Divers conduct training and certification in placing underwater demolition charges.	
Long Description	Underwater explosive charges, typically up to 20 lb. NEW, are placed on the bottom and detonated to complete training qualification or certification.	
Information Typical to the Event	**Platform:** Small boats, helicopters **Systems:** None **Ordnance/Munitions:** Explosive charges (up to 20 lb.) **Targets:** None	**Location:** Mariana Islands Range Complex Underwater Demolition Sites, 20 lb. NEW maximum charge (except Piti 10 lb. NEW maximum)
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Under water explosions (e.g., E5, E6), vessel noise, aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material	None. Detonation residue is depleted in event.	
Assumptions Used for Analysis	None	

A.1.9.8 Intelligence, Surveillance, Reconnaissance (ISR)

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Naval Special Warfare</td></tr>
<tr><td>Intelligence, Surveillance, Reconnaissance (ISR)</td><td colspan="2">Special Warfare units train to collect and report battlefield intelligence.</td></tr>
<tr><td>Long Description</td><td colspan="2">Personnel conduct event to evaluate the battlefield, enemy forces, and gather intelligence. For training of assault forces, “red cell” units may be positioned ahead of the assault force and permitted a period of time to conduct surveillance and prepare defenses to the assaulting force.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Small boats, rotor-wing aircraft, unmanned aerial vehicles
Systems: None
Ordnance/Munitions: None
Targets: None</td><td>Location:
Mariana Islands Range Complex; Guam; Tinian; Rota; Saipan</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Vessel noise, aircraft noise
Energy: None
Physical Disturbance and Strike: Vessel strike, aircraft strike (birds only), physical disturbance (sea turtle nests)
Entanglement: None
Ingestion: None</td></tr>
<tr><td>Detailed Military Expended Material</td><td colspan="2">None</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="2">None</td></tr>
</table>

A.1.9.9 Urban Warfare Training

Activity Name	**Activity Description**	
Naval Special Warfare		
Urban Warfare Training	Special Warfare units train in mock urban environments.	
Long Description	Patrols use advanced, offensive, close-quarters battle techniques to move through a hostile urban environment where noncombatants are or may be present and collateral damage must be kept to a minimum. Techniques used include: advanced breaching to enter buildings or clear rooms; clearing stairwells; selective target engagement to ensure noncombatants are not harmed; and dynamic assault techniques to ensure collateral damage is kept to a minimum.	
Information Typical to the Event	**Platform:** Rotor-wing aircraft, unmanned aerial vehicles **Systems:** None **Ordnance/Munitions:** Blanks, Simunitions **Targets:** None	**Location:** Mariana Islands Range Complex; Guam; Tinian; Rota; Saipan
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, weapon firing noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	None	

A.1.9.10 Underwater Survey

Activity Name	Activity Description	
Naval Special Warfare		
Underwater Survey	Navy divers train in survey of underwater conditions and features in preparation for insertion, extraction, or intelligence, surveillance, and reconnaissance activities.	
Long Description	A survey of underwater terrain conditions near shore and a report of findings to provide precise analysis for amphibious landings. Personnel perform methodical reconnoitering of beaches and surf conditions during the day and night to find and clear underwater obstacles and determine the feasibility of landing an amphibious force on a particular beach.	
Information Typical to the Event	**Platform:** Small boats **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** None	**Location:** Mariana Islands Range Complex
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise **Energy:** None **Physical Disturbance and Strike:** None **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	None	

A.1.10 OTHER

A.1.11 SURFACE SHIP SONAR MAINTENANCE

Activity Name	Activity Description	
Other		
Surface Ship Sonar Maintenance	In-port and at-sea maintenance of sonar systems.	
Long Description	This scenario consists of surface combatant vessels performing periodic maintenance to the hull-mounted mid-frequency sonar while in port or at sea. This maintenance takes up to four hours. Surface vessels operate active sonar systems for maintenance while in shallow water near their homeport, however, sonar maintenance could occur anywhere as the system's performance may warrant.	
Information Typical to the Event	**Platform:** Surface combatant vessels **Systems:** Mid-frequency hull mounted sonar systems **Ordnance/Munitions:** None **Targets:** None **Duration:** Up to 4 hours	**Location:** Mariana Islands Training and Testing Study Area > 3 nm from land; Inner Apra Harbor
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency sonar (e.g., MF1, MF2), vessel noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.1 Submarine Sonar Maintenance

Activity Name	Activity Description	
Other-Maintenance		
Submarine Sonar Maintenance	In-port and at-sea maintenance of sonar systems.	
Long Description	A submarine performs periodic maintenance on the AN/BQQ-10 and submarine high-frequency sonar systems while in port or at sea. Submarines conduct maintenance to their sonar systems in shallow water near their homeport however, sonar maintenance could occur anywhere as the system's performance may warrant	
Information Typical to the Event	**Platform:** Submarines **Systems:** High-frequency submarine sonar system, AN/BBQ-10 **Ordnance/Munitions:** None **Targets:** None **Duration:** 45 minutes up to 1 hour	**Location:** Mariana Islands Training and Testing Study Area > 3 nm from land; Inner Apra Harbor
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency sonar (e.g., MF3) **Energy:** None **Physical Disturbance and Strike:** Vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.2 Small Boat Attack

Activity Name	Activity Description	
Other		
Small Boat Attack	For this activity, one or two small boats or personal watercraft conduct attack activities on units afloat.	
Long Description	Small attacks are conducted on boats. For this activity, one or two small boats or personal watercraft conduct attack activities on units afloat.	
Information Typical to the Event	**Platform:** Small boats or watercraft **Systems:** None **Ordnance/Munitions:** Small-caliber (non-explosive) **Targets:** High-performance small boats and unmanned vehicles **Duration:** None	**Location:** Mariana Islands Training and Testing Study Area > 3 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, weapon firing noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	Small-caliber projectiles	
Assumptions used for Analysis	None	

A.1.11.3 Submarine Navigation

Activity Name	Activity Description	
Other		
Submarine Navigation	Submarine crews locate underwater objects and ships while transiting out of port.	
Long Description	Submarine crews train to operate sonar for navigation. The ability to navigate using sonar is critical for object detection while transiting in and out of port during periods of reduced visibility. Submarine Navigation training activities conducted while transiting in and out of port are done so while surfaced, with bridge watches and a single lookout.	
Information Typical to the Event	**Platform:** Submarines **Systems:** High-frequency submarine sonar system **Ordnance/Munitions:** None **Targets:** None **Duration:** Up to 2 hours	**Location:** Apra Harbor and Mariana littorals
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Submarine sonar noise (e.g., MF3, HF1) **Energy:** None **Physical Disturbance and Strike:** Vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.4 Search and Rescue at Sea

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Other</td></tr>
<tr><td>Search and Rescue at Sea</td><td colspan="2">Vessels and aircraft conduct search and rescue of personnel and vessels at sea.</td></tr>
<tr><td>Long Description</td><td colspan="2">United States Coast Guard vessels, Navy vessels, and rotor-wing and fixed-wing aircraft coordinate on scene actions to search and conduct rescue and recovery of personnel or vessels at sea.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Ships, rotor-wing aircraft, fixed-wing aircraft, unmanned aerial vehicles
Systems: None
Ordnance/Munitions: None
Targets: None
Duration: Up to 3 days</td><td>Location:
Mariana Islands Test and Training Study Area</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Vessel noise, aircraft noise
Energy: None
Physical Disturbance and Strike: Vessel strike, aircraft strike (birds only)
Entanglement: None
Ingestion: None</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">None</td></tr>
<tr><td>Assumptions used for Analysis</td><td colspan="2">None</td></tr>
</table>

A.1.11.5 Precision Anchoring

Activity Name	Activity Description	
Other Training		
Precision Anchoring	Releasing of anchors in designated locations.	
Long Description	Vessels navigate to a pre-planned position and deploy the anchor. The vessel uses all means available to determine its position when anchor is dropped to demonstrate calculating and plotting the anchor's position within 100 yards of center of planned anchorage.	
Information Typical to the Event	**Platform:** All surface vessels **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** Up to 1 hour	**Location:** Mariana Islands anchorages
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, seafloor device strike (anchor) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.6 Maneuver (Convoy, Land Navigation)

Activity Name	Activity Description	
Other Training		
Maneuver (Convoy, Land Navigation)	Units conduct field maneuver training or convoy training.	
Long Description	Personnel participate in land navigation and convoy training. They practice convoy maneuvers to learn how to react if their vehicle comes under fire, hits a roadside bomb, or breaks down, and how to protect themselves if they are forced to abandon their vehicle.	
Information Typical to the Event	**Platform:** Convoy vehicles **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** Up to 1 hour	**Location:** Mariana Islands Range Complex; Guam; Tinian
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** None **Energy:** None **Physical Disturbance and Strike:** None **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.7 Water Purification

Activity Name	Activity Description	
Other Training		
Water Purification	Units conduct water purification training using water purification equipment in field conditions.	
Long Description	Personnel utilize water purification equipment to purify salt water or fresh water from field sources and properly dispose of filtered effluent.	
Information Typical to the Event	**Platform:** None **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** Up to 1 day	**Location:** Mariana Islands Range Complex; Guam; Tinian
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vehicle noise **Energy:** None **Physical Disturbance and Strike:** Physical disturbance (sea turtles and nests) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.8 Field Training Exercise

Activity Name	Activity Description	
Other Training		
Field Training Exercise	Units train in securing an area, establishing a camp or post, and guarding and patrolling. Event typically lasts a week or a few days.	
Long Description	Units train in securing an area, establishing a camp or post, and guarding and patrolling. Event typically lasts a week or a few days.	
Information Typical to the Event	**Platform:** None **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** 2–3 days	**Location:** Mariana Islands Range Complex; Guam; Tinian; Rota; Saipan
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** None **Energy:** None **Physical Disturbance and Strike:** Physical disturbance (camp footprint limited to areas not restricted to training) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.9 Force Protection

Activity Name	Activity Description	
Other Training		
Force Protection	Units train in providing force protection against a terror threat.	
Long Description	Force protection operations increase the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers, detection, and assessment of threats, delay, or denial of access of the adversary to their target, appropriate response to threats and attack, and mitigation of effects of attack. Force protection includes employment of offensive as well as defensive measures.	
Information Typical to the Event	**Platform:** Rotor wing-aircraft **Systems:** None **Ordnance/Munitions:** Blanks, Simunitions **Targets:** None **Duration:** None	**Location:** Mariana Islands Range Complex; Guam; Tinian; Rota
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.10 Anti-Terrorism

Activity Name	Activity Description	
Other Training		
Anti-Terrorism	Units train in providing force protection against a terror threat.	
Long Description	Anti-Terrorism operations concentrate on the deterrence of terrorism through active and passive measures, including the collection and dissemination of timely threat information, conducting information awareness programs, coordinated security plans, and personal training. The goal is to develop protective plans and procedures based upon likely threats and strike a reasonable balance between physical protection, mission requirements, critical assets and facilities, and available resources to include manpower.	
Information Typical to the Event	**Platform:** Rotor-wing aircraft **Systems:** None **Ordnance/Munitions:** Blanks, Simunitions **Targets:** None **Duration:** None	**Location:** Mariana Islands Range Complex; Guam; Tinian; Rota
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.11 Seize Airfield

Activity Name	Activity Description	
Other Training		
Seize Airfield	Train Naval Special Warfare, Navy Expeditionary Combat Command or Marine Corps personnel to seize control of an airfield or port for use by friendly forces.	
Long Description	Units use advanced, offensive, raid and close-quarters battle techniques to move through a hostile environment where noncombatants are or may be present and collateral damage must be kept to a minimum in order to be able to use the airfield facilities after they have been seized. Includes establishing a temporary forward operating base with supporting expeditionary logistic operations (e.g., cargo drop).	
Information Typical to the Event	**Platform:** Rotor-wing and fixed-wing aircraft **Systems:** None **Ordnance/Munitions:** Blanks, Simunitions, pyrotechnics (smoke and flares) **Targets:** None **Duration:** Up to 2 weeks	**Location:** Mariana Islands Range Complex airfields
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, Generator noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only), physical disturbance and clearing (camp footprint limited to areas not restricted to training) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.12 Airfield Expeditionary

Activity Name	**Activity Description**	
Other Training		
Airfield Expeditionary	Units conduct training establishing, securing, maintaining, or operating an expeditionary airfield.	
Long Description	Conduct airfield operations in an expeditionary environment, providing force protection and repairs to facilities, while supporting airfield operations for forward deployed combat forces. Includes establishing a forward operating base with supporting expeditionary logistic operations (e.g., cargo drop).	
Information Typical to the Event	**Platform:** Fixed-wing and rotor-wing aircraft **Systems:** None **Ordnance/Munitions:** Blanks, Simunitions, pyrotechnics (smoke and flares) **Targets:** None **Duration:** Up to 4 weeks	**Location:** Mariana Islands Range Complex airfields
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, Generator noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only), physical disturbance and clearing (camp footprint limited to areas not restricted to training) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.13 Unmanned Aerial Vehicle Operation

Activity Name	Activity Description	
Other		
Unmanned Aerial Vehicle Operation	Units conduct training with unmanned aerial vehicles from airfields or in the battlefield.	
Long Description	Conduct unmanned aerial vehicle activity in support of tactical and theater requirements.	
Information Typical to the Event	**Platform:** Unmanned aerial vehicles **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** None	**Location:** Mariana Islands Training and Testing Study Area; Mariana Islands Range Complex airfields; Mariana Islands Special Use Airspace
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	None	

A.1.11.14 Land Demolitions (Improvised Explosive Device Discovery/Disposal)

Activity Name	Activity Description	
Other		
Land Demolitions (Improvised Explosive Device Discovery/Disposal)	Explosive Ordnance units conduct training detecting, isolating, or securing Improvised Explosive Devices or unexploded ordnance.	
Long Description	Explosive Ordnance Disposal detachments transit to the training site in trucks or other light wheeled vehicles, sometimes conducting convoy operations or employing other unit tactics proceeding to the site. A search of a suspect area is conducted to locate inert land mines or to locate a designated target for destruction. Buried land mines and unexploded ordnance require the detachment to employ probing techniques and metal detectors for locating the mine or object and the use of hand tools and digging equipment to excavate them.	
Information Typical to the Event	**Platform:** Ground vehicles **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** None	**Location:** Mariana Islands Range Complex; Guam
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** None **Energy:** None **Physical Disturbance and Strike:** None **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.1.11.15 Land Demolitions (Unexploded Ordnance) Discovery/Disposal

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Other</td></tr>
<tr><td>Land Demolitions (Unexploded Ordnance) Discovery/Disposal</td><td colspan="2">Explosive Ordnance units conduct disposal of unexploded ordnance at approved DoD sites. Training is incidental to the emergency disposal of unexploded ordnance.</td></tr>
<tr><td>Long Description</td><td colspan="2">Emergency disposal of unexploded ordnance, once exposed and/or properly identified, is conducted in a controlled environment at an approved site.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: None
Systems: None
Ordnance/Munitions: None
Targets: None
Duration: None</td><td>Location:
200 events Navy Emergency Disposal Site; 36 events Air Force Explosive Ordnance Disposal Sites (Guam)</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Explosive charge (on DoD property at approved sites).
Energy: None
Physical Disturbance and Strike: None
Entanglement: None
Ingestion: None</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">None</td></tr>
<tr><td>Assumptions used for Analysis</td><td colspan="2">None</td></tr>
</table>

A.2 NAVAL AIR SYSTEMS COMMAND TESTING ACTIVITIES

Naval Air Systems Command events will closely follow fleet primary mission areas, such as the testing of airborne mine warfare and anti-submarine warfare weapons and systems. Naval Air Systems Command events include, but are not limited to, the testing of new aircraft platforms, weapons, and systems that have not been integrated into fleet training events, such as directed energy weapons and the Joint Strike Fighter. In addition to testing new platforms, weapons, and systems, Naval Air Systems Command also conducts lot acceptance testing of airborne weapons and sonobuoys in support of the fleet. These types of events do not fall within one of the fleet primary mission areas; however, in general, most Naval Air Systems Command testing events in terms of their potential environmental effects are similar to Fleet training events.

While many of these systems will eventually be used by the fleet during normal training and will be addressed in this EIS/OEIS for those fleet activities, testing and development activities involving the same or similar systems as will be used by operational fleet units may be used in different locations and manners than when actually used by operational fleet units. Hence, the analysis for testing events and training of Fleet units may differ.

A.2.1 ANTI-SURFACE WARFARE TESTING

A.2.1.1 Air-to-Surface Missile Test

Activity Name	Activity Description	
Anti-Surface Warfare		
Air-to-Surface Missile Test	This event is similar to the training event missile exercise (air-to-surface). Test may involve both fixed-wing and rotary-wing aircraft launching missiles at surface maritime targets to evaluate the weapon system or as part of another systems integration test.	
Long Description	Similar to a missile exercise air-to-surface, an Air-to-Surface Missile Test for fixed-wing aircraft launching missiles at surface maritime targets to evaluate the weapons system or as part of another integration test. Air-to-Surface Missile Tests can include high-explosive, non-explosive, or non-firing (captive air training missile) weapons. Both stationary and mobile targets would be utilized during testing; some operational tests would use missiles with explosive warheads and some missiles tested will have non-explosive warheads with a live motor.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft **Systems:** Missile systems **Ordnance/Munitions:** Harpoon **Targets:** Stationary and mobile surface marine targets **Duration:** 2–4 flight hours/event	**Location:** Mariana Islands Training and Testing Study Area > 50 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise, weapons firing noise, underwater explosion (E10) **Energy:** None **Physical Disturbance and Strike:** Military expended material strike (missiles), aircraft strike (birds only) **Entanglement:** None **Ingestion:** Missile fragments, target fragments	
Detailed Military Expended Material Information	Missile and target fragments	
Assumptions used for Analysis	One air-to-surface missile per event; 50 percent will be explosive.	

A.2.2 Anti-Submarine Warfare Testing

A.2.2.1 Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft (Sonobuoys)

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Anti-Submarine Warfare</td></tr>
<tr><td>Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft (Sonobouys)</td><td colspan="2">This event is similar to the training event, Anti-Submarine Warfare Tracking Exercise–Maritime Patrol Aircraft. The test evaluates the sensors and systems used by maritime patrol aircraft to detect and track submarines and to ensure that aircraft systems used to deploy the tracking systems perform to specifications and meet operational requirements.</td></tr>
<tr><td>Long Description</td><td colspan="2">Similar to an Anti-Submarine Warfare Tracking Exercise-Maritime Patrol Aircraft. Anti-Submarine Warfare Tracking Test—Maritime Patrol Aircraft evaluates the sensors and systems used to detect and track submarines and to ensure that platform systems used to deploy the tracking systems perform to specifications and meet operational requirements. P-3 or P-8A fixed-wing aircraft conduct Anti-Submarine Warfare testing using tonal sonobuoys (e.g., AN/SSQ-62 DICASS), explosive sonobuoys (e.g., AN/SSQ-110 Improved Extended Echo Ranging), passive sonobuoys (e.g., AN/SSQ-53), torpedoes (e.g., MK-46), smoke devices (e.g., MK-58), SUS devices (e.g., MK-61 SUS), missiles (e.g., harpoons), and flares. Targets (e.g., MK-39 Expendable Mobile Anti-Submarine Warfare Training Target) may also be employed during an Anti-Submarine Warfare scenario. Some Anti-Submarine Warfare Maritime Patrol Aircraft Tracking Test could be conducted as part of a Coordinated Event with fleet training activities.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Fixed-wing Maritime Patrol Aircraft (e.g., P-3, P-8A)
Systems: Tonal sonobuoys (e.g., AN/SSQ-62 DICASS); passive sonobuoys (e.g., AN/SSQ-53); explosive sonobuoys (e.g., AN/SSQ-110 Improved Extended Echo Ranging),
Ordnance/Munitions: Non-explosive, all recovered; other non-explosive class stores (1000 lb.) torpedoes, smoke devices, flares, missiles, SUS devices
Targets: MK-39 or MK-30
Duration: 4–6 flight hours/event</td><td>Location:
Mariana Islands Training and Testing Study Area > 3 nm from land</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Mid-frequency sonobuoys (e.g., ASW2, MF5, MF6), underwater explosives (e.g., E3, E4), aircraft noise
Energy: None
Physical Disturbance and Strike: Military expended material strike, in-water device strike, aircraft strike (birds only)
Entanglement: Parachutes
Ingestion: Parachutes, Sonobuoy fragments, torpedo fragments</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">One MK-39 or MK-30 target (MK-30 is recovered and reused, MK-39 is not)
If target air dropped, one parachute per target.
20–60 sonobuoys per event (one parachute per sonobuoy)</td></tr>
<tr><td>Assumptions used for Analysis</td><td colspan="2">Torpedo, missile, flare use will be captured under Anti-submarine warfare Torpedo Test, Anti-surface Warfare Missile Test, and Flare Test, respectively; Chaff will also be captured under Flare Test. Analysis of these systems will not be conducted as part of this activity.</td></tr>
</table>

A.2.2.2 Anti-Submarine Warfare Torpedo Test

Activity Name	Activity Description
Anti-Submarine Warfare	
Anti-Submarine Warfare Torpedo Test	This event is similar to the training event, Torpedo Exercise. Test evaluates Anti-submarine warfare systems onboard rotary-wing and fixed-wing aircraft and the ability to search for, detect, classify, localize, and track a submarine or similar target.
Long Description	Similar to a Torpedo Exercise, an Anti-Submarine Warfare Torpedo Test evaluates Anti-Submarine Warfare systems onboard rotary-wing (e.g., MH-60R helicopter) and fixed-wing Marine Patrol Aircraft (e.g., P-8, P-3) aircraft and the ability to search for, detect, classify, localize, track, and attack a submarine or similar target (e.g., MK-39 Expendable Mobile Anti-Submarine Warfare Training Target, or MK-30). The focus of the Anti-Submarine Warfare Torpedo test is on the torpedo and torpedoes (e.g., MK-46 or MK-54), but other Anti-Submarine Warfare systems are often used during the test, such as AN/AQS-22 dipping sonar (MH-60R) and sonobuoys (e.g., AN/SSQ-62). MK-39 or MK-30 targets simulate an actual submarine threat and are deployed at varying depths and speeds. This activity can be conducted in shallow or deep waters and aircraft can originate from a land base or from a surface ship. The Torpedo Test culminates with the release of an exercise torpedo against the target and is intended to evaluate the targeting, release, and tracking process of deploying torpedoes from aircraft. All exercise torpedoes used in testing are either running (EXTORP) or non-running (REXTORP). Non-explosive torpedoes are recovered. A parachute assembly and guidance wire used for aircraft-launched torpedoes is jettisoned and sinks. Ballast (typically lead weights) may be released from the torpedoes to allow for recovery and sink to the bottom.
Information Typical to the Event	**Platform:** Fixed and rotary-wing aircraft (e.g., P-3/P-8, MH-60R), support vessels **Systems:** Dipping sonar (e.g., AN/AQS-22); sonobuoys (e.g., AN/SSQ-62) **Ordnance/Munitions:** Torpedoes (e.g., MK-46, MK-54, and MK-56; non-explosive) **Targets:** MK-39 Expendable Mobile Anti-Submarine Warfare Training Target or MK-30 **Duration:** 2–6 flight hours/event **Location:** Mariana Islands Training and Testing Study Area > 3 nm from land
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Mid-frequency sonar (MF5, MF6), lightweight torpedoes (TORP1), aircraft noise, vessel noise **Energy:** None **Physical Disturbance and Strike:** Military expended material strike, aircraft strike (birds only), vessel strike **Entanglement:** Parachutes, guidance wire **Ingestion:** Parachutes, target fragments
Detailed Military Expended Material Information	Torpedo accessories (e.g., parachute assembly, guidance wire) Sonobuoys Ballast Target & torpedo fragments
Assumptions used for Analysis	Assume one torpedo accessory package (parachute, ballast, guidance wire) per torpedo. Assume one target per torpedo. Assume 12 sonobuoys per event. Assume 15 percent of torpedoes are not recovered.

A.2.2.3 Broad Area Maritime Surveillance Testing – MQ-4C Triton

Activity Name	Activity Description	
Anti-Submarine Warfare		
Broad Area Maritime Surveillance (BAMS) Testing – MQ-4C Triton	The Broad Area Maritime Surveillance system will fill a complementary role to the P-8A aircraft, providing maritime reconnaissance support to the Navy.	
Long Description	The MQ-4C Triton BAMS system will be equipped with electro-optical/infrared sensors, can remain on station for 30 hours, and fly at approximately 60,000 feet (18,288 meters).	
Information Typical to the Event	**Platform:** Maritime Patrol Aircraft, MQ-4C Triton **Systems:** None **Ordnance/Munitions:** None **Targets:** None **Duration:** Up to 30 hours	**Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** None **Energy:** None **Physical Disturbance and Strike:** None **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions used for Analysis	None	

A.2.3 Electronic Warfare

A.2.3.1 Flare Test

Activity Name	Activity Description	
Electronic Warfare (EW)		
Flare Test	Flare tests evaluate newly developed or enhanced flares, flare dispensing equipment, or modified aircraft systems against flare deployment. Tests may also train pilots and aircrew in the use of newly developed or modified flare deployment systems. Flare tests are often conducted with other test events, and are not typically conducted as standalone tests. Chaff and flares are expended for this test event.	
Long Description	Flare tests are conducted to evaluate new flares, newly developed or modified flare deployment systems, to ensure that other newly enhanced aircraft systems are compatible with flare deployment, and to train pilots and aircrew in the use of newly developed or modified flare deployment systems. Flare tests are often conducted with other test events, and are not typically conducted as stand-alone tests. During a flare test, flares (and in some cases chaff) are deployed, but no weapons are typically fired. Fixed-wing aircraft deploy flares as a defensive tactic to disrupt the infrared missile guidance systems used by heat-seeking missiles, thereby causing the missile to lock onto the flare instead of onto the aircraft and enabling the aircraft to avoid the threat. In a typical scenario, an aircraft may detect the electronic targeting signals emitted from threat radars or missiles, or aircrew may visually identify a threat missile plume when a missile is launched. At a strategically appropriate time, the pilot dispenses flares and immediately maneuvers the aircraft to distract and defeat the threat. During a typical flare test, an aircraft will dispense flares 3,000 feet above mean sea level and flares are completely consumed while in the air. Aircraft flares use a magnesium extruded flare grain. Flare types commonly deployed during NAVAIR testing activities include but are not limited to: MJU-57, MJU-49, and MJU-38 for high speed aircraft and MJU-32 for low speed aircraft.	
Information Typical to the Event	**Platform:** Fixed-wing aircraft **Systems:** Flares: MJU-57, MJU-49, and MJU-38 for high speed aircraft and MJU-32; Joint Allied Threat Assessment System/Common Infrared Countermeasures **Ordnance/Munitions:** None **Targets:** None **Duration:** 2–4 flight hours/event	**Location:** Offshore Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Aircraft noise **Energy:** None **Physical Disturbance and Strike:** Aircraft strike (birds only) **Entanglement:** None **Ingestion:** End caps, chaff	
Detailed Military Expended Materials Information	Flares (end caps and pistons) Chaff	
Assumptions Used for Analysis	Flare use from all other events are captured under this activity. Estimated 30 flares per event Estimated 60 chaff canisters per event	

A.3 NAVAL SEA SYSTEMS COMMAND TESTING ACTIVITIES

Naval Sea Systems Command testing activities are aligned with its mission of new ship construction, life cycle support, and weapon systems development. Each major category of Naval Sea Systems Command activities is described below.

A.3.1 LIFECYCLE ACTIVITIES

Testing activities are conducted throughout the lifecycle of a Navy ship to verify performance and mission capabilities.

A.3.1.1 Ship Signature Testing

Activity Name	Activity Description	
Lifecycle Activities		
Ship Signature Testing	Tests ship and submarine radars, electromagnetic, or acoustic signatures.	
Long Description	Radar cross signature testing of surface vessels is accomplished on new vessels and periodically throughout a vessel's lifecycle to measure how detectable the vessel is to radar. For example, Assessment Identification of Mine Susceptibility measurements are specific electromagnetic and passive acoustical tests performed on mine countermeasure vessels and on the Littoral Combat Ship mine countermeasure modules to determine their mine susceptibility. Additionally, measurements of deployed electromagnetic countermeasures are conducted during the new construction, post-delivery, and lifecycle phases of the acquisition process for submarines. Signature testing of all surface vessels and submarines verifies that each vessel's signature is within specifications, and may include the use of helicopter-deployed instrumentation, ship-mounted safety and navigation systems, fathometers, tracking devices, radar systems, and underwater communications equipment. Event duration includes all systems checks, including those that do not have active sonar.	
Information Typical to the Event	**Platform:** All surface vessel and submarine classes **Systems:** Navigation, underwater communication, sonar **Ordnance/Munitions:** None **Targets:** None **Duration:** None	**Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, underwater communications sonar (M3, MF9, and MF10), and hull-mounted sonar (MF2) **Energy:** None **Physical Disturbance and Strike:** Vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions Used for Analysis	None	

A.3.2 ANTI-SURFACE WARFARE/ANTI-SUBMARINE WARFARE TESTING

A.3.2.1 Kinetic Energy Weapon Testing

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Anti-Surface Warfare (ASUW)</td></tr>
<tr><td>Kinetic Energy Weapon Testing</td><td colspan="2">A kinetic energy weapon uses stored energy released in a burst to accelerate a non-explosive projectile.</td></tr>
<tr><td>Long Description</td><td colspan="2">A kinetic energy weapon uses stored energy released in a burst to accelerate a non-explosive projectile to more than seven times the speed of sound to a range of up to 200 miles.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Surface combatant
Systems: Kinetic energy weapon
Ordnance/Munitions: Large-caliber projectile (non-explosive)
Targets: Recoverable or expendable floating or in-air target
Duration: Event duration is 1 day.</td><td>Location:
Study Area</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Weapons firing noise, vessel noise
Energy: None
Physical Disturbance and Strike: Military expended material strike (non-explosive projectile), vessel strike
Entanglement: None
Ingestion: None</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">50 events with no more than 40 large-caliber projectiles per event
A one-time event only for this EIS/OEIS with 5,000 large-caliber projectiles
Expendable target – 1 target per event</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="2">Assume one target per event.
A one-time event with 5,000 projectiles would occur only once for this EIS/OEIS.</td></tr>
</table>

A.3.2.2 Torpedo Testing

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">Anti-Surface Warfare/Anti-Submarine Warfare Testing</td></tr>
<tr><td>Torpedo Testing</td><td colspan="2">Air, surface, or submarine crews employ (non-explosive and explosive) torpedoes against submarines, surface vessels, or artificial targets.</td></tr>
<tr><td>Long Description</td><td colspan="2">Non-explosive and explosive torpedoes (carrying a warhead) would be launched at a suspended target by a submarine and fixed- or rotary-winged aircraft or surface combatants. Torpedoes would detonate on an artificial target located at a depth between 200 and 700 feet below the water’s surface.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Submarine, surface combatant vessel, fixed-wing aircraft, rotary-wing aircraft, support craft/other
Systems: None
Ordnance/Munitions: Torpedoes (heavyweight and lightweight) (explosive and non-explosive)
Targets: Stationary artificial targets (e.g., MK 28)
Duration: 1–2 days during daylight hours. Only one heavyweight torpedo test could occur in 1 day; two heavyweight torpedo tests could occur on consecutive days. Two lightweight torpedo tests could occur in a single day.</td><td>Location:
Mariana Islands Range Complex</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Underwater explosion (e.g., E8, E11), torpedo sonar (e.g., TORP1, TORP2), vessel noise, aircraft noise
Energy: None
Physical Disturbance and Strike: Vessel strike, in-water device strike, aircraft strike (birds only)
Entanglement: Parachutes (sonobuoy and torpedo), guidance wire
Ingestion: Target and torpedo fragments, parachutes (sonobuoy and torpedo), torpedo launch accessories</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">Torpedo launch accessories
o Lightweight/heavy weight torpedo launch accessories
o Nose cap, suspension bands, air stabilizer, sway brace pad, arming wire, Fahnstock clip, wing kit, rocket booster, parachute, lead weights
o Expended material is dependent upon torpedo fired and firing platform.
Heavyweight torpedo launch accessories.
Guidance wire, flex hose.</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="2">All sonobuoys have a parachute unless otherwise noted.
210 passive sonobuoys per event.</td></tr>
</table>

A.3.2.3 Countermeasure Testing

Activity Name	Activity Description
Anti-Surface Warfare/Anti-Submarine Warfare Testing	
Countermeasure Testing	Various acoustic systems (e.g., towed arrays and defense systems) are employed to detect, localize, track, and neutralize incoming weapons.
Long Description	Countermeasure testing involves the testing of systems that would detect, localize, and track incoming weapons. At-sea testing of the Surface Ship Torpedo Defense systems include towed acoustic systems, torpedo warning systems, and countermeasure anti-torpedo subsystems. Some countermeasure scenarios would employ torpedoes against targets released by secondary platforms (e.g., helicopter or submarine). While surface vessels are in transit, countermeasure systems will be used to identify false alert rates. Additionally, systems may be tested pierside to verify functionality.
Information Typical to the Event	**Platform:** Aircraft carrier, surface combatant, submarine, fixed-wing aircraft, helicopters **Systems:** Countermeasure systems **Ordnance/Munitions:** Lightweight torpedoes **Targets:** Torpedo test vehicle **Duration:** 4 hours to 10 days (depending on the countermeasure being tested) **Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** High-frequency sonar (e.g., HF5), acoustic countermeasure (e.g., ASW3), torpedo sonar (e.g., TORP1), vessel noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, In-water device strike, aircraft noise, aircraft strike (birds only), military expended material strike **Entanglement:** Parachute (torpedo) **Ingestion:** Torpedo launch accessories
Detailed Military Expended Material Information	Torpedo launch accessories (nose covers, parachutes, ram plates)
Assumptions Used for Analysis	None

A.3.2.4 At-Sea Sonar Testing

Activity Name	Activity Description	
Surface Warfare/Anti-Submarine Warfare Testing		
At-sea Sonar Testing	At-sea testing to ensure sonar systems are fully functional in an open ocean environment.	
Long Description	At-sea sonar testing is required to calibrate sonar systems while the vessel or submarine is in an open ocean environment. Tests consist of electronic support measurement, photonics, and sonar sensor accuracy testing. In some instances, a submarine's passive detection capability is tested when a second submarine utilizes its active sonar or is equipped with a noise augmentation system in order to replicate acoustic or electromagnetic signatures of other vessel types or classes.	
Information Typical to the Event	**Platform:** Surface combatant vessels, submarines **Systems:** Tactical sonar, acoustic countermeasures **Ordnance/Munitions:** None **Targets:** None **Duration:** 4 hours to 11 days	**Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** High-frequency acoustic (e.g., HF1,HF6), mid-frequency acoustic (e.g., MF1, MF3, MF9, MF10, MF11), low-frequency acoustic (LF5, ASW1), acoustic modem (M3), vessel noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	None	
Assumptions Used for Analysis	Active sonar use is intermittent throughout the duration of the event. Acoustic countermeasures – 10 per event.	

A.3.3 SHIPBOARD PROTECTION SYSTEMS AND SWIMMER DEFENSE TESTING

A.3.3.1 Pierside Integrated Swimmer Defense

Activity Name	Activity Description	
Shipboard Protection Systems and Swimmer Defense Testing		
Pierside Integrated Swimmer Defense	Swimmer defense testing ensures that systems can effectively detect, characterize, verify, and engage swimmer/diver threats in harbor environments.	
Long Description	Swimmer defense testing includes testing of systems to determine if they can effectively detect, characterize, verify, and engage swimmer/diver threats in harbor environments. Swimmer and diver threats are detected with high frequency sonar. The threats are then warned to exit the water through the use of underwater voice communications. If the threat does not comply, non-lethal diver deterrent air guns are used against the threat. Surface loudhailers are also used during the test.	
Information Typical to the Event	**Platform:** Support craft/other **Systems:** Sonar, swimmer defense airguns surface loudhailers **Ordnance/Munitions:** None **Targets:** None **Duration:** 28 days with intermittent periods of use for each system during this time.	**Location:** Inner and Outer Apra Harbor
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Low-frequency sonar (e.g., LF4), mid-frequency sonar (e.g., MF8), swimmer defense sonar (e.g., SD1), airguns (e.g., AG), vessel noise **Energy:** None **Physical Disturbance and Strike:** Seafloor device strike (swimmer defense tripod), vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material	None	
Assumptions Used for Analysis	**Other Sensors:** Surface ship protection systems (e.g., communications systems, loudhailers, swimmer deterrents)	

A.3.4 NEW SHIP CONSTRUCTION

Ship construction activities include the integration and testing of new mission packages.

A.3.4.1 Anti-Submarine Warfare Mission Package Testing

Activity Name	Activity Description	
New Ship Construction		
Anti-Submarine Warfare Mission Package Testing	Vessels and their supporting platforms (e.g., helicopters, unmanned aerial vehicles) detect, localize, and prosecute submarines.	
Long Description	Vessels conduct detect-to-engage operations against modern diesel-electric and nuclear submarines using airborne and surface assets (both manned and unmanned). Active and passive acoustic systems are used to detect and track submarine targets.	
Information Typical to the Event	**Platform:** Surface combatant vessels (e.g., Littoral Combat Ship); rotary-wing aircraft, Submarines **Systems:** Surface ship sonar, helicopter-deployed sonar, active sonobuoys **Ordnance/Munitions:** **Targets:** Motorized Autonomous Targets (e.g., Expendable Mobile Anti-Submarine Warfare Training Target) **Duration:** Event duration is approximately 1–2 weeks, with 4–8 hours of active sonar use with intervals of non-activity in between.	**Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Low-frequency sonar (LF6), mid-frequency sonar (MF12), helicopter-deployed sonar (MF4), active sonobuoys (MF5), anti-submarine sonar (ASW1), countermeasures (ASW3), vessel noise and aircraft noise **Energy:** None **Physical Disturbance and Strike:** Vessel strike, towed in-water device strike, aircraft strike **Entanglement:** Parachutes **Ingestion:** Parachutes	
Detailed Military Expended Material Information	Sonobuoys, parachutes	
Assumptions Used for Analysis	One target per event All sonobuoys have a parachute unless otherwise noted. 2 sonobuoys per event	

A.3.4.2 Mine Countermeasure Mission Package Testing

<table>
<tr><th>Activity Name</th><th colspan="2">Activity Description</th></tr>
<tr><td colspan="3">New Ship Construction</td></tr>
<tr><td>Mine Countermeasure Mission Package Testing</td><td colspan="2">Vessels and associated aircraft conduct mine countermeasure operations.</td></tr>
<tr><td>Long Description</td><td colspan="2">Littoral Combat Ships conduct mine detection using unmanned submersible and aerial vehicles, magnetic and acoustic sensor systems deployed by vessel or support helicopters, and laser systems. Mines are then neutralized using magnetic, acoustic, and supercavitating systems.</td></tr>
<tr><td>Information Typical to the Event</td><td>Platform: Surface combatant Ship, Unmanned Underwater Vehicles, rotary aircraft
Systems: Towed sonar system
Ordnance/Munitions: Mine neutralization systems (e.g., Airborne Mine Neutralization System)
Targets: Floating/moored/bottom non-explosive, mines or passive mine simulation systems
Duration: 1–2 weeks with intervals of mine countermeasure mission package use during this time.</td><td>Location:
Mariana Islands Training and Testing Study Area</td></tr>
<tr><td>Potential Impact Concerns
(Information regarding deconstruct categories and stressors)</td><td colspan="2">Acoustic: Towed sonar systems (HF4), underwater explosions (E4), aircraft noise, vessel noise
Energy: Electromagnetic devices, in-air low energy lasers
Physical Disturbance and Strike: Vessel strike, in-water device strike, aircraft strike (birds only), seafloor devices (e.g., mine shapes, mine shape mooring anchor)
Entanglement: None
Ingestion: Fragments</td></tr>
<tr><td>Detailed Military Expended Material Information</td><td colspan="2">Neutralizer fragments</td></tr>
<tr><td>Assumptions Used for Analysis</td><td colspan="2">Four neutralizer charges/event</td></tr>
</table>

A.3.4.3 Anti-Surface Warfare Mission Package Testing

Activity Name	Activity Description	
New Ship Construction		
Anti-Surface Warfare Mission Package Testing	Vessels and associated aircraft track and engage against surface targets	
Long Description	Littoral Combat Ships conduct surface warfare by detecting, tracking, and prosecuting surface vessel threats. The Surface Warfare Mission Package provides a layered strike/defensive capability by use of its embarked support aircraft, medium range surface-to-surface missiles, and gun weapon systems.	
Information Typical to the Event	**Platform:** Littoral Combat Ship, unmanned aerial vehicles, rotary aircraft **Systems:** Missiles and large-, medium-, and small-caliber guns **Ordnance/Munitions:** Anti-surface vessel missile (e.g., Griffin); gun projectiles (e.g., 57mm, 30mm, and .50 cal.) **Targets:** Free floating or towed surface targets **Duration:** Conducted in intervals over 1–2 weeks	**Location:** Mariana Islands Training and Testing Study Area; Warning Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, weapon firing noise, aircraft noise, in-air explosives, underwater explosions (E1, E6) **Energy:** None **Physical Disturbance and Strike:** Vessel strike, aircraft strike (birds only), military expended material strike **Entanglement:** None **Ingestion:** Projectiles/projectile fragments; missile or rocket fragments	
Detailed Military Expended Material Information	Projectiles/projectile fragments, casings Missile or rocket fragments	
Assumptions Used for Analysis	500 small-caliber projectiles per event/510 explosive and 510 non-explosive medium-caliber rounds per event/980 explosive and 420 non-explosive large-caliber rounds per event/4 explosive missiles or rockets per event and 4 non-explosive missiles or rockets per event.	

A.4 OFFICE OF NAVAL RESEARCH AND NAVAL RESEARCH LABORATORY TESTING ACTIVITIES

As the Department of the Navy's Science and Technology provider, the Office of Naval Research and the Naval Research Laboratory provide technology solutions for Navy and Marine Corps needs. The Office of Naval Research's mission, as defined by law, is to plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security. Further, the Office of Naval Research manages the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test and evaluation.

The Ocean Battlespace Sensing Department explores science and technology in the areas of oceanographic and meteorological observations, modeling and prediction in the battlespace environment; submarine detection and classification (anti-submarine warfare); and mine warfare applications for detecting and neutralizing mines in both the ocean and littoral environment. Office of Naval Research events include: research, development, test and evaluation activities; surface processes acoustic communications experiments; shallow water acoustic communications experiments; sediment acoustics experiments; shallow water acoustic propagation experiments; and long range acoustic propagation experiments.

A.4.1 OFFICE OF NAVY RESEARCH

A.4.1.1 North Pacific Acoustic Lab Philippine Sea 2018–19 Experiment (Deep Water)

Activity Name	**Activity Description**	
RDT&E Testing		
North Pacific Acoustic Lab Philippine Sea 2018–19 Experiment (Deep Water)	The primary purpose of the Kauai Acoustic Communications Experiment is to collect acoustic and environmental data appropriate for studying the coupling of oceanography, acoustics, and underwater communications.	
Long Description	The experiment area encompasses international waters. The initial experiment was completed in May of 2011; an acoustic tomography array, a distributed vertical line array (DVLA), and moorings were deployed in the deep-water environment of the northwestern Philippine Sea. The acoustic tomography array and DVLA have remained in situ at the experiment site since that time, collecting oceanographic and acoustic data used to study deep-water propagation and to characterize the temperature and velocity structure in this oceanographically complex and highly dynamic region. In addition, data will be collected during two periods of intensive experimental at-sea operations in May and July of 2018. During the fall of 2018 data will be collected passively by remotely sensing seagliders. Research vessels, acoustic test sources, side scan sonar, ocean gliders, the existing moored acoustic tomographic array and distributed vertical line array, and other oceanographic data collection equipment will be used to collect information on the ocean environment. The final phases of the experiment will be completed during March through May 2019. The resulting analyses will aid in developing a more complete understanding of deep water sound propagation and the temperature-velocity profile of the water column in this part of the world.	
Information Typical to the Event	**Platform:** Research vessels **Systems:** Ocean gliders. **Ordnance/Munitions:** None **Targets:** None **Duration:** 1–2 weeks	**Location:** Mariana Islands Training and Testing Study Area
Potential Impact Concerns *(Information regarding deconstruct categories and stressors)*	**Acoustic:** Vessel noise, high frequency sonar, acoustic modems, acoustic test sources **Energy:** None **Physical Disturbance and Strike:** Seafloor devices, vessel strike **Entanglement:** None **Ingestion:** None	
Detailed Military Expended Material Information	Mooring blocks	
Assumptions Used for Analysis	None	

This Page Intentionally Left Blank

Appendix B: Notice of Intent

ACTION: Proposed Additions to the Procurement List.

SUMMARY: The Committee is proposing to add products and services to the Procurement List that will be furnished by nonprofit agencies employing persons who are blind or have other severe disabilities.

Comments Must Be Received on or Before: 10/17/2011.

ADDRESSES: Committee for Purchase From People Who Are Blind or Severely Disabled, Jefferson Plaza 2, Suite 10800, 1421 Jefferson Davis Highway, Arlington, Virginia 22202–3259.

FOR FURTHER INFORMATION OR TO SUBMIT COMMENTS CONTACT: Barry S. Lineback, Telephone: (703) 603–7740, Fax: (703) 603–0655, or e-mail *CMTEFedReg@AbilityOne.gov.*

SUPPLEMENTARY INFORMATION: This notice is published pursuant to 41 U.S.C. 47(a)(2) and 41 CFR 51–2.3. Its purpose is to provide interested persons an opportunity to submit comments on the proposed actions.

Additions

If the Committee approves the proposed additions, the entities of the Federal Government identified in this notice will be required to procure the products and services listed below from nonprofit agencies employing persons who are blind or have other severe disabilities.

Regulatory Flexibility Act Certification

I certify that the following action will not have a significant impact on a substantial number of small entities. The major factors considered for this certification were:

1. If approved, the action will not result in any additional reporting, recordkeeping or other compliance requirements for small entities other than the small organizations that will furnish the products and services to the Government.

2. If approved, the action will result in authorizing small entities to furnish the products and services to the Government.

3. There are no known regulatory alternatives which would accomplish the objectives of the *Javits-Wagner-O'Day Act* (41 U.S.C. 46–48c) in connection with the products and services proposed for addition to the Procurement List.

Comments on this certification are invited. Commenters should identify the statement(s) underlying the certification on which they are providing additional information.

End of Certification

The following products and services are proposed for addition to the Procurement List for production by the nonprofit agencies listed:

Products

NSN: 7930–00–NIB–0583—Refills, Bathroom Cleaner and Deodorizer, Cartridge Concentrate.

NSN: 7930–00–NIB–0584—Starter Kit, Bathroom Cleaner and Deodorizer, Cartridge Concentrate.

NSN: 7930–00–NIB–0585—Refills, Glass and Hard Surface Cleaner, Cartridge Concentrate.

NSN: 7930–00–NIB–0586—Starter Kit, Glass and Hard Surface Cleaner, Cartridge Concentrate.

NSN: 7930–00–NIB–0591—Refills, Disinfectant Cleaner-Degreaser Cartridge Concentrate.

NSN: 7930–00–NIB–0592—Starter Kit, Disinfectant Cleaner-Degreaser Cartridge Concentrate.

NSN: 7930–00–NIB–0593—Refills, Multi-Purpose Cleaner, Cartridge Concentrate.

NSN: 7930–00–NIB–0594—Starter Kit, Multi-Purpose Cleaner, Cartridge Concentrate.

NPA: Association for Vision Rehabilitation and Employment, Inc., Binghamton, NY.

Contracting Activity: General Services Administration, Fort Worth, TX

Coverage: A-List for the Total Government Requirement as aggregated by the General Services Administration.

Services

Service Type/Location: Grounds & Cemetery Facilities Maintenance, Fort McClellan Veterans Cemetery and Prisoner of War Cemetery, Anniston, AL.

NPA: The Opportunity Center Easter Seal Facility—The Ala ES Soc, Inc., Anniston, AL.

Contracting Activity: DEPT OF THE ARMY, W0LX ANNISTON DEPOT PROP DIV, ANNISTON, AL.

Service Types/Location: Janitorial Service, Grounds Maintenance Service, William Jefferson Clinton Birthplace Home National Historic Site (NHS), 117 S. Hervey St., Hope, AR.

NPA: Rainbow of Challenges, Inc., Hope, AR.

Contracting Activity: DEPARTMENT OF THE INTERIOR, NATIONAL PARK SERVICE, MIDWEST REGION, OMAHA, NE.

Barry S. Lineback,

Director, Business Operations.

[FR Doc. 2011–23804 Filed 9–15–11; 8:45 am]

BILLING CODE 6353–01–P

DEPARTMENT OF DEFENSE

Department of the Air Force

Intent To Grant an Exclusive Patent License

SUMMARY: Pursuant to the provisions of part 404 of Title 37, Code of Federal Regulations, which implements Public Law 96–517, as amended, the Department of the Air Force announces its intention to grant Eclipse Composites Engineering, LLC, a corporation of Utah, having a place of business at 78 West 13775, South #1, Draper, UT, 84020, an exclusive license in any right, title and interest the United States Air Force has in: U.S. Patent Application No. 12/932,341, filed on February 23, 2011, entitled "Resin-Based Molding of Electrically Conductive Structures" by David J. Legare as sole inventor.

FOR FURTHER INFORMATION CONTACT: An exclusive license for the invention described in this patent application will be granted unless a written objection is received within fifteen (15) days from the date of publication of this Notice. Written objections should be sent to: Air Force Research Laboratory, Office of the Staff Judge Advocate, AFRL/RIJ, 26 Electronic Parkway, Rome, New York 13441–4514. Telephone: (315) 330–2087; Facsimile (315) 330–7583.

Bao-Anh Trinh,

DAF, Air Force Federal Register Liaison Officer.

[FR Doc. 2011–23750 Filed 9–15–11; 8:45 am]

BILLING CODE 5001–10–P

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent To Prepare an Environmental Impact Statement/ Overseas Environmental Impact Statement for Military Readiness Activities in the Mariana Islands Training and Testing Study Area and To Announce Public Scoping Meetings; Correction

AGENCY: Department of Navy, DoD.

ACTION: Notice; correction.

SUMMARY: The Department of the Navy published a document in the **Federal Register** (76 FR 174) on September 8, 2011, concerning public scoping meetings to support the development of an Environmental Impact Statement/ Overseas Environmental Impact Statement for the Mariana Islands Training and Testing Study Area. The document contained an incorrect scoping date.

FOR FURTHER INFORMATION CONTACT: Ms. Nora Macariola—See, Naval Facilities Engineering Command, Pacific, *Attention:* MITT EIS/OEIS, 258 Makalapa Drive, Suite 100, Building 258, Floor 3, Pearl Harbor, Hawaii 96860–3134.

Correction: In the **Federal Register** (76 FR 174) of September 8, 2011, on page

55654, in the first column, correct the last public scoping date to read:

3. Thursday, September 29, 2011, at the Sinapalo Elementary School Cafeteria, Sinapalo I, Songsong Village, Rota, MP 96951.

Dated: September 9, 2011.

L.M. Senay,

Lieutenant, Judge Advocate General's Corps, U.S. Navy, Alternate Federal Register Liaison Officer.

[FR Doc. 2011–23755 Filed 9–15–11; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF EDUCATION

Notice of Submission for OMB Review

AGENCY: Department of Education.

ACTION: Comment request.

SUMMARY: The Director, Information Collection Clearance Division, Privacy, Information and Records Management Services, Office of Management, invites comments on the submission for OMB review as required by the Paperwork Reduction Act of 1995 (Pub. L. 104–13).

DATES: Interested persons are invited to submit comments on or before October 17, 2011.

ADDRESSES: Written comments should be addressed to the Office of Information and Regulatory Affairs, Attention: Education Desk Officer, Office of Management and Budget, 725 17th Street, NW., Room 10222, New Executive Office Building, Washington, DC 20503, be faxed to (202) 395–5806 or e-mailed to *oira_submission@omb.eop.gov* with a cc: to *ICDocketMgr@ed.gov*. Please note that written comments received in response to this notice will be considered public records.

SUPPLEMENTARY INFORMATION: Section 3506 of the Paperwork Reduction Act of 1995 (44 U.S.C. chapter 35) requires that the Office of Management and Budget (OMB) provide interested Federal agencies and the public an early opportunity to comment on information collection requests. The OMB is particularly interested in comments which: (1) Evaluate whether the proposed collection of information is necessary for the proper performance of the functions of the agency, including whether the information will have practical utility; (2) Evaluate the accuracy of the agency's estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used; (3) Enhance the quality, utility, and clarity of the information to be collected; and (4) Minimize the burden of the collection of information on those who are to respond, including through the use of appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology.

Dated: September 13, 2011.

Darrin King,

Director, Information Collection Clearance Division, Privacy, Information and Records Management Services, Office of Management.

Office of Elementary and Secondary Education

Type of Review: Extension.

Title of Collection: Annual Report of Children in State Agency and Locally Operated Institutions for Neglected and Delinquent Children.

OMB Control Number: 1810–0060.

Agency Form Number(s): Department of Education (ED) Form 4376.

Frequency of Responses: Annually.

Affected Public: State, Local or Tribal Governments.

Total Estimated Number of Annual Responses: 3,552.

Total Estimated Annual Burden Hours: 4,564.

Abstract: An annual survey is conducted to collect data on (1) the number of children enrolled in educational programs of State-operated institutions for neglected or delinquent (N or D) children, community day programs for N or D children, and adult correctional institutions and (2) the October caseload of N or D children in local institutions.

Copies of the information collection submission for OMB review may be accessed from the RegInfo.gov Web site at *http://www.reginfo.gov/public/do/PRAMain* or from the Department's Web site at *http://edicsweb.ed.gov*, by selecting the "Browse Pending Collections" link and by clicking on link number 4662. When you access the information collection, click on "Download Attachments" to view. Written requests for information should be addressed to U.S. Department of Education, 400 Maryland Avenue, SW., LBJ, Washington, DC 20202–4537. Requests may also be electronically mailed to the Internet address *ICDocketMgr@ed.gov* or faxed to 202–401–0920. Please specify the complete title of the information collection and OMB Control Number when making your request.

Individuals who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 1–800–877–8339.

[FR Doc. 2011–23830 Filed 9–15–11; 8:45 am]

BILLING CODE 4000–01–P

DEPARTMENT OF EDUCATION

Notice of Submission for OMB Review

AGENCY: Department of Education.

ACTION: Comment request.

SUMMARY: The Director, Information Collection Clearance Division, Privacy, Information and Records Management Services, Office of Management, invites comments on the submission for OMB review as required by the Paperwork Reduction Act of 1995 (Pub. L. 104–13).

DATES: Interested persons are invited to submit comments on or before October 17, 2011.

ADDRESSES: Written comments should be addressed to the Office of Information and Regulatory Affairs, Attention: Education Desk Officer, Office of Management and Budget, 725 17th Street, NW., Room 10222, New Executive Office Building, Washington, DC 20503, be faxed to (202) 395–5806 or e-mailed to *oira_submission@omb.eop.gov* with a cc: to *ICDocketMgr@ed.gov*. Please note that written comments received in response to this notice will be considered public records.

SUPPLEMENTARY INFORMATION: Section 3506 of the Paperwork Reduction Act of 1995 (44 U.S.C. chapter 35) requires that the Office of Management and Budget (OMB) provide interested Federal agencies and the public an early opportunity to comment on information collection requests. The OMB is particularly interested in comments which: (1) Evaluate whether the proposed collection of information is necessary for the proper performance of the functions of the agency, including whether the information will have practical utility; (2) Evaluate the accuracy of the agency's estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used; (3) Enhance the quality, utility, and clarity of the information to be collected; and (4) Minimize the burden of the collection of information on those who are to respond, including through the use of appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology.

Dated: September 13, 2011.

Darrin King,

Director, Information Collection Clearance Division, Privacy, Information and Records Management Services, Office of Management.

National Center for Education Statistics

Type of Review: Revision.

Title of Collection: High School Longitudinal Study of 2009 (HSLS:09)

(viii) *Date Report Delivered to Congress:* August 30, 2011.

Policy Justification

Norway—Procure and Install Equipment on P–3C Aircraft

The Government of Norway has requested a possible sale for the procurement and installation of 4 AN/USQ–78B Acoustic Processor Technology Refresh (APTR), 4AN/ASQ–227 Aircraft Mission Computers, and 2 Tactical Mobile Acoustic Support Systems on four Royal Norwegian Air Force P–3C aircraft, spare and repair parts, support and test equipment, publications and technical documentation, personnel training and training equipment, U.S. Government and contractor engineering, technical and logistics support services, and other related elements of logistical and program support. The estimated cost is $95 million.

This proposed sale will contribute to the foreign policy and national security of the United States by helping to improve the security of a NATO ally that has been, and continues to be, an important force for economic and political stability.

The proposed sale will update hardware and ensure the sustainment of data provided to the United States as part of various data sharing agreements already in place with the Government of Norway in the area of anti-submarine warfare. Norway will have no difficulty absorbing the additional equipment into its armed forces.

The proposed sale of this equipment and support will not alter the basic military balance in the region.

The prime contractor will be Lockheed Martin Corporation in Owego, New York. Offset agreements associated with this proposed sale are expected, but at this time the specific offset agreements are undetermined and will be defined in negotiations between the purchaser and contractors.

Implementation of this proposed sale will require U.S. Government and contractor representatives to travel to Norway to participate in periodic program technical reviews, training and support visits, and maintenance and support visits semi-annually for a period of four years.

There will be no adverse impact on U.S. defense readiness as a result of this proposed sale.

[FR Doc. 2011–22930 Filed 9–7–11; 8:45 am]

BILLING CODE 5001–06–P

DEPARTMENT OF DEFENSE

Office of the Secretary

Meeting of the Defense Advisory Committee on Women in the Services (DACOWITS)

AGENCY: Department of Defense.

ACTION: Notice.

SUMMARY: Pursuant to Section 10 (a), Public Law 92–463, as amended, notice is hereby given of a forthcoming meeting of the Defense Advisory Committee on Women in the Services (DACOWITS). The purpose of the meeting is for the Committee to receive a follow-up briefing from the Sexual Assault Prevention and Response Office and the Services on the Committee's requests for information concerning sexual assault and sexual harassment. Additionally, the Committee will develop and approve recommendations for the 2011 report. The meeting is open to the public, subject to the availability of space.

Interested persons may submit a written statement for consideration by the Defense Advisory Committee on Women in the Services. Individuals submitting a written statement must submit their statement to the Point of Contact listed below at the address detailed below no later than 5 p.m., Tuesday, September 20, 2011. If a written statement is not received by Tuesday, September 20, 2011, prior to the meeting, which is the subject of this notice, then it may not be provided to or considered by the Defense Advisory Committee on Women in the Services until its next open meeting. The Designated Federal Officer will review all timely submissions with the Defense Advisory Committee on Women in the Services Chairperson and ensure they are provided to the members of the Defense Advisory Committee on Women in the Services. If members of the public are interested in making an oral statement, a written statement should be submitted as above. After reviewing the written comments, the Chairperson and the Designated Federal Officer will determine who of the requesting persons will be able to make an oral presentation of their issue during an open portion of this meeting or at a future meeting. Determination of who will be making an oral presentation is at the sole discretion of the Committee Chair and the Designated Federal Officer and will depend on time available and if the topics are relevant to the Committee's activities. Two minutes will be allotted to persons desiring to make an oral presentation. Oral presentations by members of the public will be permitted only on Thursday, September 22, 2011 from 4:15 p.m. to 5 p.m. in front of the full Committee. Number of oral presentations to be made will depend on the number of requests received from members of the public.

DATES: September 22, 2011, 8 a.m.–5 p.m.; September 23, 2011, 8 a.m.–12 p.m.

ADDRESSES: Sheraton National Hotel, 900 Orme St, Arlington, VA 22204.

FOR FURTHER INFORMATION CONTACT: Mr. Robert Bowling or DACOWITS Staff at 4000 Defense Pentagon, Room 2C548A, Washington, DC 20301–4000. E-mail: Robert.bowling@osd.mil. Telephone (703) 697–2122. Fax (703) 614–6233.

SUPPLEMENTARY INFORMATION:

Meeting Agenda

Thursday, September 22, 2011, 8 a.m.–5 p.m.

—Welcome, introductions, and announcements.
—Receive briefings from the Sexual Assault Prevention and Response Office on sexual assault and harassment information.
—Receive briefings from the Services on sexual assault and harassment information.
—Public Forum.

Friday, September 23, 2011, 8 a.m.–12 p.m.

—Committee develops and approves recommendations for 2011 report.

Dated: September 2, 2011.

Aaron Siegel,

Alternate OSD Federal Register Liaison Officer, Department of Defense.

[FR Doc. 2011–23002 Filed 9–7–11; 8:45 am]

BILLING CODE 5001–06–P

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent To Prepare an Environmental Impact Statement/Overseas Environmental Impact Statement for Military Readiness Activities in the Mariana Islands Training and Testing Study Area and To Announce Public Scoping Meetings

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: Pursuant to section 102(2)(c) of the National Environmental Policy Act of 1969, as implemented by the Council on Environmental Quality Regulations (40 Code of Federal Regulations parts 1500–1508), and

Executive Order 12114, the Department of the Navy (DoN) announces its intent to prepare an Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to evaluate the potential environmental effects associated with maintaining military readiness training and research, development, testing, and evaluation (hereafter referred to as "training and testing") activities conducted in the Mariana Islands Training and Testing (MITT) EIS/OEIS Study Area. The MITT Study Area includes the existing Mariana Islands Range Complex (MIRC), additional areas on the high seas, and a general transit corridor between Hawaii to MITT where training and testing activities may occur. The MIRC is the only major Navy range complex in the Study Area.

The DoN is preparing this EIS/OEIS to renew current regulatory permits and authorizations, address current training and testing not covered under existing permits and authorizations, and to obtain those permits and authorizations necessary to support force structure changes and emerging and future training and testing requirements including those associated with new platforms and weapons systems within the MITT Study Area, starting in 2015, thereby ensuring critical Department of Defense (DoD) requirements are met.

The DoN will invite the National Marine Fisheries Service, United States (U.S.) Fish and Wildlife Service (Pacific Islands Fish and Wildlife Office), and U.S. Air Force, to be cooperating agencies in preparation of the EIS/OEIS.

DATES AND ADDRESSES: Five public scoping meetings will be held between 5 and 8 p.m. on:

1. Thursday, September 22, 2011, at the University of Guam, Leon Guerrero School of Business and Public Administration Building, Anthony Leon Guerrero Multi-Purpose Room 129, Mangilao, Guam 96923.
2. Friday, September 23, 2011, at the Southern High School Cafeteria, #1 Jose Perez Leon Guerrero Drive, Santa Rita, Guam 96915.
3. Monday, September 26, 2011, at the Multi-Purpose Center in Susupe, Saipan 96950.
4. Tuesday, September 27, 2011, at the Tinian High School Cafeteria, San Jose Village, Tinian, MP 96952.
5. Wednesday, September 28, 2011, at the Sinapalo Elementary School Cafeteria, Sinapalo I, Songsong Village, Rota, MP 96951

Each of the five scoping meetings will consist of an informal, open house session with information stations staffed by DoN representatives. Meeting details will be announced in local newspapers. Additional information concerning meeting times will be available on the EIS/OEIS Web page located at: *http://www.mitt-eis.com.*

FOR FURTHER INFORMATION CONTACT: Ms. Nora Macariola-See, Naval Facilities Engineering Command, Pacific, Attention: MITT EIS/OEIS, 258 Makalapa Drive, Suite 100, Building 258, Floor 3, Pearl Harbor, Hawaii 96860–3134.

SUPPLEMENTARY INFORMATION: The DoN's proposed action is to conduct military training and testing activities, including the use of active sonar and explosives, within the MITT Study Area. While the majority of training and testing activities take place in established training and testing areas, some activities, such as sonar maintenance and gunnery exercises are conducted concurrent with normal transits.

The MIRC is one component of the MITT Study Area, encompassing 501,873 square nautical miles of open ocean. In addition to the areas covered within the MIRC, the Study Area also includes additional areas on the high seas and transit corridors where training and testing activities may occur.

The proposed action is to conduct military training and testing activities in the MITT study area. The purpose of the proposed action is to achieve and maintain military readiness to meet the requirements of Title 10 of the U.S. Code, thereby ensuring that the DoN and other Services meet their mission to maintain, train, and equip combat-ready military forces capable of winning wars, deterring aggression, and maintaining freedom of the seas.

Three alternatives will be analyzed in the MITT EIS/OEIS. The No Action Alternative would continue baseline training and testing activities, as defined by existing environmental planning documents.

Alternative 1 consists of baseline training and testing activities and overall expansion of the Study Area plus adjustments to types and levels of activities as necessary to support current and planned military training and testing requirements. This Alternative considers activities conducted throughout the Study Area and mission requirements associated with force structure changes, including those resulting from the development, testing, and ultimate introduction of new platforms (vessels, aircraft) and weapons systems.

Alternative 2 consists of Alternative 1 plus the establishment of new range capabilities, modifications of existing capabilities, adjustments to type and tempo of training and testing activities, and the establishment of additional locations to conduct training and testing activities within the Study Area.

Resource areas that will be addressed because of the potential effects from the Proposed Action include, but are not limited to, ocean and biological resources (including marine mammals and threatened and endangered species), terrestrial resources, air quality, noise, cultural resources, transportation, regional economy, recreation, and public health and safety.

The scoping process will be used to identify community concerns and local issues that will be addressed in the EIS/OEIS. Federal agencies, state agencies, local agencies, the public, and interested persons are encouraged to provide comments to the DoN to identify specific issues or topics of environmental concern that the commenter believes the DoN should consider. All comments provided orally or in writing at the scoping meetings, will receive the same consideration during EIS/OEIS preparation. Written comments must be postmarked no later than November 7, 2011, and should be mailed to: Naval Facilities Engineering Command, Pacific, 258 Makalapa Drive, Suite 100, Pearl Harbor, HI 96869–3134, Attention: MITT EIS/OEIS Project Manager.

Dated: September 1, 2011.

L.M. Senay,

Lieutenant, Judge Advocate General's Corps, U.S. Navy, Alternate Federal Register Liaison Officer.

[FR Doc. 2011–22985 Filed 9–7–11; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF EDUCATION

Notice of Proposed Information Collection Requests

AGENCY: Department of Education.

ACTION: Comment request.

SUMMARY: The Department of Education (the Department), in accordance with the Paperwork Reduction Act of 1995 (PRA) (44 U.S.C. 3506(c)(2)(A)), provides the general public and Federal agencies with an opportunity to comment on proposed and continuing collections of information. This helps the Department assess the impact of its information collection requirements and minimize the reporting burden on the public and helps the public understand the Department's information collection requirements and provide the requested data in the desired format. The Director, Information Collection Clearance Division, Privacy, Information and

Appendix C: Agency Correspondence

APPENDIX C AGENCY CORRESPONDENCE

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/1137
30 Aug 2011

xxxxxx
xxxxxx
xxxxxx

Dear Name:

Subj: NOTIFICATION OF PREPARATION OF THE MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS)

This letter is to inform you that the United States (U.S.) Navy, on behalf of the U.S. military services, is preparing an EIS/OEIS to assess the potential environmental impacts from proposed military readiness training and research, development, testing and evaluation activities ("training and testing activities") in the MITT Study Area. Some of these proposed training and testing activities may include the use of active sonar and explosives. The services request your comments on the scope, content and issues to be considered in the development of the EIS/OEIS.

The MITT Study Area is comprised of air, land and sea space and includes the existing Mariana Islands Range Complex (MIRC), additional areas on the high seas and a transit corridor where training and testing activities may occur (see Enclosure 1). The MIRC is the only Navy range complex in the Study Area.

The Proposed Action is to conduct military training and testing activities in the MITT Study Area. The purpose of the Proposed Action is to achieve and maintain military readiness to meet the requirements of Title 10 of the U.S. Code, thereby ensuring that the military services meet their mission to maintain, train and equip combat-ready military forces capable of winning wars, deterring aggression and maintaining freedom of the seas.

Subj: NOTIFICATION OF PREPARATION OF THE MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS)

The Proposed Action would support military training and testing activities associated with the development, testing and introduction of new vessels, aircraft and weapons systems within the MITT Study Area to ensure critical military requirements are met. This action is needed to support applicable environmental reauthorizations, consultations and other associated environmental requirements for those training and testing activities. The MITT EIS/OEIS is the reevaluation and reauthorization of training and testing activities reviewed in the MIRC EIS/OEIS, which the Navy completed with community input in 2010.

Environmental issues to be addressed in the EIS/OEIS include, but are not limited to, the following resource areas: ocean and biological resources (including marine mammals and threatened and endangered species), terrestrial resources, air quality, airborne soundscape, cultural resources, transportation, regional economy, recreation, and public health and safety. Your input in identifying specific issues and concerns that should be assessed, in these areas and any additional areas, is important to the process.

In compliance with the National Environmental Policy Act of 1969 (NEPA) and the National Historic Preservation Act, the Navy is holding five open house public scoping meetings to support an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to the Proposed Action. Scoping meetings will inform the public of the Proposed Action and NEPA process and give community members an opportunity to submit written and oral comments on the scope, environmental resources and local issues to be addressed in the EIS/OEIS. Input from the public scoping meetings will be used to help identify potentially significant issues to be analyzed in the Draft EIS/OEIS.

The public scoping meetings will be conducted in an open house format and members of the public may arrive at any time during the meetings. There will be no formal presentation; however, service representatives will be available to provide information and answer questions about the Proposed Action.

2

Subj: NOTIFICATION OF PREPARATION OF THE MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS)

The public scoping meetings will be held from **5 to 8 p.m.** at the following locations:

On Guam: **Thursday, Sept. 22, 2011**
University of Guam
Leon Guerrero School of Business and Public Administration Building,
Anthony Leon Guerrero Multi-Purpose Room 129
Mangilao, Guam 96923

Friday, Sept. 23, 2011
Southern High School, Cafeteria
#1 Jose Perez Leon Guerrero Drive
Santa Rita, Guam 96915

On Saipan: **Monday, Sept. 26, 2011**
Multi-Purpose Center in Susupe
Saipan, MP 96950

On Tinian: **Tuesday, Sept. 27, 2011**
Tinian High School, Cafeteria
San Jose Village
Tinian, MP 96952

On Rota: **Thursday, Sept. 29, 2011**
Sinapalo Elementary School, Cafeteria
Sinapalo I, Songsong Village
Rota, MP 96951

Regardless of whether you are able to participate in the public scoping meetings, you may send written comments to:

Naval Facilities Engineering Command, Pacific
Attention: MITT EIS/OEIS Project Manager
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

You may also submit comments online at **www.mitt-eis.com**. All comments must be postmarked or received online by **Nov. 7, 2011**, to be considered in the development of the Draft EIS/OEIS.

3

Subj: NOTIFICATION OF PREPARATION OF THE MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS)

For more information, please visit the project website at **www.mitt-eis.com** or contact Ms. Nora Macariola-See, Navy Technical Representative, (808) 472-1402, email nora.macariola-see@navy.mil.

Sincerely,

Larry M. Foster

L. M. FOSTER
Director, Environmental Readiness
By direction

Enclosure: 1. MITT Study Area

4

Enclosure: 1. Mariana Islands Training and Testing (MITT) Study Area

5

This Page Intentionally Left Blank

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

5090
N454/11U158200
15 September 2011

Mr. Timothy K. Bridges
Deputy Assistant Secretary of the Air Force
(Environment, Safety and Occupational Health)
HQ SAF/IEE
1670 Air Force Pentagon
Washington, D.C. 20330-1760

Dear Mr. Bridges:

Subj: MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS) – COOPERATING AGENCY

In accordance with the National Environmental Policy Act (NEPA), the United States (U.S.) Department of the Navy (Navy) is initiating the preparation of an Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to evaluate the potential environmental effects associated with military readiness training and research, development, testing, and evaluation (hereafter referred to as "training and testing") activities that include the use of active sonar and explosives in the Mariana Islands Training and Testing (MITT) EIS/OEIS Study Area. The MITT Study Area includes the existing Mariana Islands Range Complex (MIRC), additional areas on the high seas, and a transit corridor where training and testing activities may occur (see enclosure (1)). The Mariana Islands Range Complex (MIRC) is the only range complex in the MITT Study Area.

The proposed action is to conduct training and testing activities in the MITT study area. The purpose of the proposed action is to achieve and maintain military readiness to meet the requirements of Title 10 of the U.S. Code, thereby ensuring that the Navy and other Services meet their mission to maintain, train, and equip combat-ready military forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. The proposed action also serves to support force structure changes and emerging and future training and testing associated with new systems within the MITT EIS/OEIS Study Area, thereby ensuring critical military requirements are met.

The following alternatives are under consideration in this EIS/OEIS:

(1) No Action Alternative: Continue baseline training and testing activities, as defined by existing environmental planning documents, including the *2010 Mariana Islands Range Complex EIS/OEIS* and the *Office of Naval Research Acoustic Impact Analysis for the North Pacific Acoustic Laboratory Philippine Sea 2010 through 2011 Experiment*.

(2) Alternative 1: Consists of baseline training and testing activities and overall expansion of the Study Area plus adjustments to types and levels of activities as necessary to support current and planned military training and testing activities requirements. This Alternative considers activities conducted throughout the Study Area and mission requirements associated with force structure changes, including those resulting from the development, testing, and ultimate introduction of new platforms (vessels, aircraft) and weapons systems.

(3) Alternative 2: Consists of Alternative 1 plus the establishment of new range capabilities, modifications of existing capabilities, adjustments to type and tempo of training and testing activities, and the establishment of additional locations to conduct training and testing activities within the Study Area.

The EIS/OEIS will analyze the effects of sound in the water on marine mammals in the areas where training activities occur. In addition, other environmental resource areas that will be addressed as applicable in the EIS/OEIS include air quality; airspace; biological resources, including threatened and endangered species; cultural resources; terrestrial resources, geology and soils; hazardous materials and waste; health and safety; land use; noise; socioeconomics; transportation; and water resources.

In order to adequately evaluate the potential environmental effects of the proposed action, DoD components need to work together in assessing potential impacts to training and testing activities within the MITT study area. To assist in this effort and in accordance with 40 Code of Federal Regulations Part 1501 and the Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002, the Navy requests that the U.S. Air Force serve as a cooperating agency for the development of the EIS/OEIS.

As defined in 40 CFR Part 1501.6, the Navy is the lead agency for the MITT EIS/OEIS. As the lead agency, the Navy shall:

- Request the participation of each cooperating agency in the NEPA process at the earliest possible time.
- Use the environmental analysis and proposals of cooperating agencies with jurisdiction by law or special expertise to the maximum extent possible consistent with its responsibility as lead agency.
- Determine scope of the EIS/OEIS, including the alternatives evaluated.
- Meet with a cooperating agency at the latter's request.
- Circulate the appropriate NEPA documentation to the general public and any other interested parties.
- Schedule and supervise meetings held in support of the NEPA process and compiling any comments received.

2

- Maintain an administrative record and respond to any Freedom of Information Act requests relating to the EIS/OEIS.

Each cooperating agency shall:

- Participate in the NEPA process at the earliest possible time.
- Participate in meetings hosted by the Navy, including public scoping meetings and hearings, for discussion of issues relating to the EIS/OEIS.
- Assume, on request of the lead agency, responsibility for developing information and preparing environmental analyses, including portions of the environmental impact statement for which the cooperating agency has special expertise.
- Make available staff support at the lead agency's request to enhance the latter's interdisciplinary capability.
- Provide comments on the draft EIS/OEIS document (Version 2.0) within 30 working days.
- Use their own funds.
- Adhere to the overall schedule as set forth by the Navy.
- Provide a formal, written response to this request.

The Navy views this agreement as important to the successful completion of the environmental planning process for the MITT EIS/OEIS. It is the Navy's goal to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in July 2013 with the Final EIS released in February 2015. The Record of Decision is anticipated to be signed in May 2015. The U.S. Air Force assistance will be invaluable in that endeavor. See enclosure 2 for the notional schedule for the MITT EIS/OEIS.

We appreciate your consideration of our request and look forward to your response. The point of contact for this matter is Ms. Dawn Schroeder at (703) 695-5219, email dawn.schroeder@navy.mil.

for

J. P. Quinn
Deputy Director, Energy and Environmental Readiness Division (OPNAV N45)

Enclosure: 1. MITT Study Area
2. Notional Schedule

3

Copy to:
PACFLT N01CE
ASN (EI&E)
DASN (E)
OAGC (EI&E)
CNIC (N45)
PACAF
COMMANDER, JOINT REGION MARIANAS
NAVFAC PACIFIC
NAVFAC MARIANAS

4

Enclosure: 1. Mariana Islands Training and Testing (MITT) Study Area

5

Enclosure 2: NOTIONAL SCHEDULE OF EVENTS

MARIANA ISLANDS TRAINING AND TESTING ENVIRONMENTAL IMPACT STATEMENT/ OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS)

Notice of Intent Published in Federal Register	September 2011
Scoping Meetings	September 2011
Request for Marine Mammal Protection Act Letter of Authorization to National Marine Fisheries Service	April 2013
Draft Environmental Impact Statement Notice of Availability	July 2013
Draft Environmental Impact Statement Public Hearings	August 2013
Final Environmental Impact Statement Notice of Availability	February 2015
Record of Decision	May 2015

6

DEPARTMENT OF THE AIR FORCE
WASHINGTON DC

OFFICE OF THE ASSISTANT SECRETARY

2 1 OCT 2011

SAF/IEE
1665 Air Force Pentagon
Washington, DC 20330-1665

Mr. J.P. Quinn
Deputy Director, Energy and Environmental
Readiness Division
Department of the Navy
Office of the Chief Naval Operations
2000 Navy Pentagon
Washington, D.C. 20330-1760

Dear Mr. Quinn:

The Air Force accepts the invitation to act as a Cooperating Agency during preparation of the Mariana Islands Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement, as prescribed in the President's Council on Environmental Quality National Environmental Policy Act (NEPA) Regulations, 40 CFR § 1501.6, *Cooperating Agencies.*

As a Cooperating Agency, the Air Force understands it is expected to participate in various portions of EIS development. As a Cooperating Agency, the Air Force shall:

a. Participate in the NEPA process, including scoping;
b. Assume responsibility, upon request by your organization, for developing information and preparing analyses on issues for which it has special expertise; and
c. Make Air Force staff available for interdisciplinary reviews.

The Air Force requests your office provide appropriate, related information in a timely fashion. In turn, the Air Force will respond in a prompt manner. The Air Force point of contact for this action is Mr. Jack Bush, HQ USAF/A7CIB at (703) 614-0237; jack.bush@pentagon.af.mil.

Sincerely,

TIMOTHY K. BRIDGES
Deputy Assistant Secretary of the Air Force
(Environment, Safety & Occupational Health)

cc:
SAF/IEI/GCN
HQ USAF/A7C
HQ USAF/A30
HQ PACAF/A7
AFLOA/JACE

This Page Intentionally Left Blank

NCIC, INFO

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

5090
N454/11158201
15 September 2011

Mr. Eric C. Schwaab
Assistant Administrator
National Marine Fisheries Service
1315 East West Highway
Silver Springs, MD 20910

Dear Mr. Schwaab:

In accordance with the National Environmental Policy Act (NEPA), the Department of the Navy (Navy) is initiating the preparation of an Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to evaluate the potential environmental effects associated with military readiness training and research, development, testing, and evaluation (hereafter referred to as "training and testing") activities that include the use of active sonar and explosives in the Mariana Islands Training and Testing (MITT) EIS/OEIS Study Area. The MITT Study Area includes the existing Mariana Islands Range Complex (MIRC), additional areas on the high seas, and a transit corridor where training and testing activities may occur (see enclosure (1)). The Mariana Islands Range Complex (MIRC) is the only Navy range complex in the MITT Study Area.

An important aspect of the MITT EIS/OEIS will be the analysis of the acoustic effects to marine species protected under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). The MITT EIS/OEIS is also intended to serve as a basis for the renewal of current regulatory permits and authorizations; address current training and testing not covered under the existing permits and authorizations; and obtain those permits and authorizations necessary to support force structure changes and emerging and future training and testing requirements. The MMPA Final Rule and ESA Section 7 Programmatic Biological Opinion for MIRC expire in August 2015 and June 2015, respectively.

To complete the analysis required by the permitting and consultation process, the Navy and the National Marine Fisheries Service (NMFS) will need to work together. Therefore, in accordance with the Council on Environmental Quality's (CEQ) NEPA guidelines (specifically 40 CFR Part 1501) and CEQ's 2002 guidance on cooperating agencies, the Navy requests that NMFS serve as a cooperating agency for the development of the MITT EIS/OEIS.

As the lead agency, the Navy will be responsible for overseeing preparation of the EIS/OEIS that will include, but not limited to, the following:

- Gathering all necessary background information and preparing all necessary permit applications associated with the proposed action.

- Working with NMFS personnel to determine the method of estimating potential effects to protected marine species, including threatened and endangered species.
- Determining the scope of the EIS/OEIS, including the alternatives evaluated.
- Circulating the appropriate NEPA documentation to the general public and any other interested parties.
- Scheduling and supervising meetings held in support of the NEPA process and compiling any comments received.
- Maintaining an administrative record and responding to any Freedom of Information Act requests relating to the EIS/OEIS.

Navy respectfully requests NMFS, in its role as a cooperating agency, provide support as follows:

- Providing timely comments after the Agency Information Meeting (which will be held at the onset of the EIS/OEIS process) and on working drafts of the EIS/OEIS documents. The Navy requests that comments on draft EIS/OEIS documents (Version 2) be provided within 30 working days.
- Responding to Navy requests for information, in particular related to review of the acoustic effects analysis and evaluation of the effectiveness of protection and mitigation measures.
- Coordinating, to the maximum extent practicable, any public comment periods required by the MMPA permitting process with the Navy's NEPA public comment periods.
- Participating, as necessary, in meetings hosted by the Navy for discussion of issues related to the EIS/OEIS, including public hearings and meetings.
- Adhering to the overall schedule as set forth by the Navy.
- Providing a formal, written response to this request.

2

The Navy views this agreement as important to the successful completion of the environmental planning process for the MITT EIS/OEIS. NMFS' assistance will be invaluable in this endeavor. Please see Enclosure 2 for the MITT EIS/OEIS notional schedule.

The point of contact for this action is Ms. Dawn Schroeder, (703) 695-5219, email: dawn.schroeder@navy.mil.

Sincerely,

J. P. QUINN
Deputy Director, Energy and Environmental
Readiness Division (OPNAV N45)

Enclosure: 1. MITT Study Area
2. Notional Schedule

Copy to:
Commander, U.S. Pacific Fleet
Commander, U.S. Fleet Forces Command
Commander, Naval Installations Command
Commander, Joint Region Marianas
Joint Guam Program Office
Commander, Naval Facilities Engineering Command, Pacific
Mr. Michael D. Tosatto, Regional Administrator, Pacific Islands Regional Office, National Marine Fisheries Service, 1601 Kapiolani Boulevard, Suite 1110, Honolulu, HI 96814

Enclosure 1: Mariana Islands Training and Testing (MITT) Study Area

4

Enclosure 2: NOTIONAL SCHEDULE OF EVENTS

MARIANA ISLANDS TRAINING AND TESTING
ENVIRONMENTAL IMPACT STATEMENT/
OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS)

Notice of Intent Published in Federal Register	September 2011
Scoping Meetings	September 2011
Request for Marine Mammal Protection Act Letter of Authorization to National Marine Fisheries Service	April 2013
Draft Environmental Impact Statement Notice of Availability	July 2013
Draft Environmental Impact Statement Public Hearings	August 2013
Final Environmental Impact Statement Notice of Availability	February 2015
Record of Decision	May 2015

This Page Intentionally Left Blank

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

THE DIRECTOR

JUL 11 2013

Mr. John P. Quinn
Deputy Director, Energy and
Environmental Readiness Division
Department of the Navy
2000 Navy Pentagon
Washington, DC 20350-2000

Dear Mr. Quinn:

Thank you for your letter requesting that NOAA's National Marine Fisheries Service (NMFS) participate as a cooperating agency in the preparation of an Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to evaluate potential environmental effects of military readiness training and research, development, testing, and evaluation (RDT&E) activities conducted within the Mariana Islands Training and Testing (MITT) Study Area. We reaffirm our support of the Navy's decision to prepare an EIS/OEIS and agree to be a cooperating agency, due, in part, to our responsibilities under section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA) and section 7 of the Endangered Species Act.

In response to your letter, NMFS staff will continue to, to the extent possible,

- Provide timely review and comments, within 30 working days, after the Agency Information Meeting and on working drafts of the EIS/OEIS documents;
- Respond to Navy requests for information, in particular those related to the acoustic effects analysis and the evaluation of the effectiveness of protection and mitigation measures, in a timely manner;
- Participate in meetings, as necessary, hosted by the Navy to discuss issues related to the EIS/OEIS, including public hearings on the draft EIS/OEIS; and
- Adhere to the overall schedule as agreed upon by NMFS and the Navy.

If you need any additional information, please contact Ms. Jolie Harrison, NMFS Office of Protected Resources, at (301) 427-8401.

Sincerely,

Samuel D. Rauch, III
Deputy Assistant Administrator
for Regulatory Programs,
performing the functions and duties of the
Assistant Administrator for Fisheries

THE ASSISTANT ADMINISTRATOR
FOR FISHERIES

Printed on Recycled Paper

This Page Intentionally Left Blank

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/0258
22 Feb 12

Mr. Loyal Mehrhoff
Field Office Supervisor
U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

Dear Mr. Mehrhoff:

Subj: MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS) - COOPERATING AGENCY

In accordance with the National Environmental Policy Act (NEPA), the Commander, U.S. Pacific Fleet is initiating the preparation of an Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) to evaluate the potential environmental effects associated with military readiness training and research, development, testing, and evaluation (hereafter referred to as "training and testing") activities that include the use of active sonar and explosives in the Mariana Islands Training and Testing (MITT) EIS/OEIS Study Area. The MITT Study Area includes the existing Mariana Islands Range Complex (MIRC), additional areas on the high seas, and a transit corridor where training and testing activities may occur (see Enclosure 1).

The proposed action is to conduct training and testing activities within the MITT study area. The purpose of the proposed action is to achieve and maintain military readiness to meet the requirements of Title 10 of the U.S. Code, thereby ensuring that the Navy and other Services meet their mission to maintain, train, and equip combat-ready military forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. The proposed action also serves to support force structure changes and emerging and future training and testing associated with new systems within the MITT EIS/OEIS Study Area, thereby ensuring critical military requirements are met.

Subj: MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS) - COOPERATING AGENCY

The following alternatives are under consideration in this EIS/OEIS:

(1) No Action Alternative: Continue baseline training and testing activities, as defined by existing environmental planning documents, including the *2010 Mariana Islands Range Complex EIS/OEIS* and the *Office of Naval Research Acoustic Impact Analysis for the North Pacific Acoustic Laboratory Philippine Sea 2010 through 2011 Experiment*.

(2) Alternative 1: Consists of baseline training and testing activities and overall expansion of the Study Area plus adjustments to types and levels of activities as necessary to support current and planned military training and testing activities requirements. This Alternative considers activities conducted throughout the Study Area and mission requirements associated with force structure changes, including those resulting from the development, testing, and ultimate introduction of new platforms (vessels, aircraft) and weapons systems.

(3) Alternative 2: Consists of Alternative 1 plus the establishment of new range capabilities, modifications of existing capabilities, adjustments to type and tempo of training and testing activities, and the establishment of additional locations to conduct training and testing activities within the Study Area.

The EIS/OEIS will analyze the effects of sound in the water on marine mammals in the areas where training activities occur. In addition, other environmental resource areas that will be addressed as applicable in the EIS/OEIS include air quality; airspace; biological resources, including threatened and endangered species; cultural resources; terrestrial resources, geology and soils; hazardous materials and waste; health and safety; land use; noise; socioeconomics; transportation; and water resources.

In order to adequately evaluate the potential environmental effects of the proposed action, the Navy and the U.S. Fish and Wildlife Service would need to work together on the analysis of

Subj: MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS) - COOPERATING AGENCY

effects to terrestrial species protected under the Endangered Species Act. To assist in this effort and in accordance with 40 Code of Federal Regulations Part 1501 and the Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002, the Navy requests that the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office serve as a cooperating agency for the development of the EIS/OEIS.

As the lead agency, the Navy will be responsible for overseeing preparation of the EIS/OEIS that includes, but is not limited to, the following:

- Gathering all necessary background information and preparing the EIS/OEIS and all necessary permit applications associated with acoustic issues within the MITT Study Area.
- Working with U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office personnel to determine the method of estimating potential effects to protected species, including threatened and endangered species.
- Determining the scope of the EIS/OEIS, including the alternatives evaluated.
- Circulating the appropriate NEPA documentation to the general public and any other interested parties.
- Scheduling and supervising meetings held in support of the NEPA process, and compiling any comments received.
- Maintaining an administrative record and responding to any Freedom of Information Act requests relating to the EIS/OEIS.

Navy respectfully requests the U.S. Fish and Wildlife Service, in its role as a cooperating agency, provide support as follows:

3

Subj: MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS) - COOPERATING AGENCY

- Providing timely comments after the Agency Information Meeting (which will be held at the onset of the EIS/OEIS process) and on working drafts of the EIS/OEIS documents. The Navy requests that comments on draft EIS/OEIS documents (Version 2) be provided within 30 working days.

- Responding to Navy requests for information. Timely U.S. Fish and Wildlife Service input will be critical to ensure a successful environmental planning process.

- Coordinating, to the maximum extent practicable, any public comment periods that are necessary in the Endangered Species Act process with the Navy's NEPA public comment periods.

- Participating, as necessary, in meetings hosted by the Navy for discussion of issues related to the EIS/OEIS, including public hearings and meetings.

- Adhering to the overall schedule as set forth by the Navy.

- Providing a formal, written response to this request.

The Navy views this agreement as important to the successful completion of the environmental planning process for the MITT EIS/OEIS. It is the Navy's goal to complete the analysis as expeditiously as possible, while using the best scientific information available. The Draft EIS is scheduled for public review in July 2013 with the Final EIS released in February 2015. The Record of Decision is anticipated to be signed in May 2015. The U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office assistance will be invaluable in that endeavor.

Subj: MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS) - COOPERATING AGENCY

We appreciate your consideration of our request and look forward to your response. The point of contact for this matter is Ms. Nora Macariola-See, NAVFAC Pacific at (808) 472-1402, email: nora.macariola-see@navy.mil).

L. M. FOSTER
Director, Environmental Readiness
By direction

Enclosure: 1. MITT Study Area

Copy to:
CNO (N45)
CNIC (N45)
COMMANDER, JOINT REGION MARIANAS
NAVFAC PACIFIC
NAVFAC MARIANAS

5

Enclosure: 1. Mariana Islands Training and Testing (MITT) Study Area

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2012-TA-0228

Mr. Larry M. Foster
Department of the Navy
250 Makalapa Drive
Pearl Harbor, Hawaii 96860-3131

MAR 27 2012

Subject: Request to be a Cooperating Agency for the Mariana Islands Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement

Dear Mr. Foster:

Thank you for your letter dated February 22, 2012, requesting the U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office (PIFWO) be a cooperating agency on the preparation of a Mariana Islands Training and Testing (MITT) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). We appreciate the offer; however, we cannot serve as a cooperating agency on the EIS/OEIS due to workload constraints.

We do recognize the importance of collaboration between the Department of Navy (DoN) and Service in preparation of the EIS/OEIS and in the section 7 consultation required under the Endangered Species (ESA) of 1973 (16 U.S.C. 1531 *et seq.*), as amended. The Service will still provide comments on preliminary or draft EIS/OEIS documents, and respond to Navy requests for biological information. We will also assist you with ensuring that the best available scientific information is used in the EIS/OEIS and that impacts to ESA-listed species and other natural resources are minimized and offset. We are interested in working collaboratively with the Navy towards these ends without being a formal cooperating agency.

If you have any questions or concerns regarding this consultation, please contact Rachel Rounds, Fish and Wildlife Biologist (phone: 808-792-9400, email: rachel_rounds@fws.gov).

Sincerely,

for Loyal Mehrhoff
Field Supervisor

TAKE PRIDE IN AMERICA

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/0888
23 July 2013

Loyal Merhoff, PhD
Field Supervisor
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard
Room 3-122
Honolulu, HI 96850

Dear Dr. Merhoff:

SUBJECT: REQUEST FOR CONCURRENCE ON SPECIES LIST AND CRITICAL HABITAT UNITS FOR THE MARIANA ISLANDS TRAINING AND TESTING (MITT) ACTION AREA

The U.S. Department of the Navy (Navy) is preparing an Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to evaluate the potential environmental effects associated with training and testing activities conducted in the MITT EIS/OEIS Study Area (see Attachment 1). A Notice of Intent (NOI) to prepare the MITT EIS/OEIS was published in the Federal Register on 8 September 2011. Scoping meetings for this EIS/OEIS were held on Guam, Rota, Tinian, and Saipan in September 2011.

In accordance with the Navy's obligations under Section 7(a)(2) of the Endangered Species Act (ESA), the Navy is requesting concurrence from your office on the species and critical habitat units under U.S. Fish and Wildlife Service jurisdiction to be included in the analysis. The list of species and critical habitat units are included in Attachment 2. Previously, the Navy completed Section 7 formal consultation with the U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office for training activities within the Mariana Islands Range Complex (MIRC) (Consultation numbers 2009-F-0345 and 2009-F-0345-R002), which provided the Navy an Incidental Take Statement (ITS), valid through August 2015.

We look forward to receiving your written concurrence on the species list and critical habitat units and engaging with the

SUBJECT: REQUEST FOR CONCURRENCE ON SPECIES LIST AND CRITICAL HABITAT UNITS FOR THE MARIANA ISLANDS TRAINING AND TESTING (MITT) ACTION AREA

Pacific Islands Fish and Wildlife Office on the MITT consultation. For any questions regarding this consultation, please contact Ms. Julie Rivers (COMPACFLT, 808-474-6391, julie.rivers@navy.mil) or Dr. Frans Juola (NAVFAC Pacific, 808-472-1433, frans.juola@navy.mil).

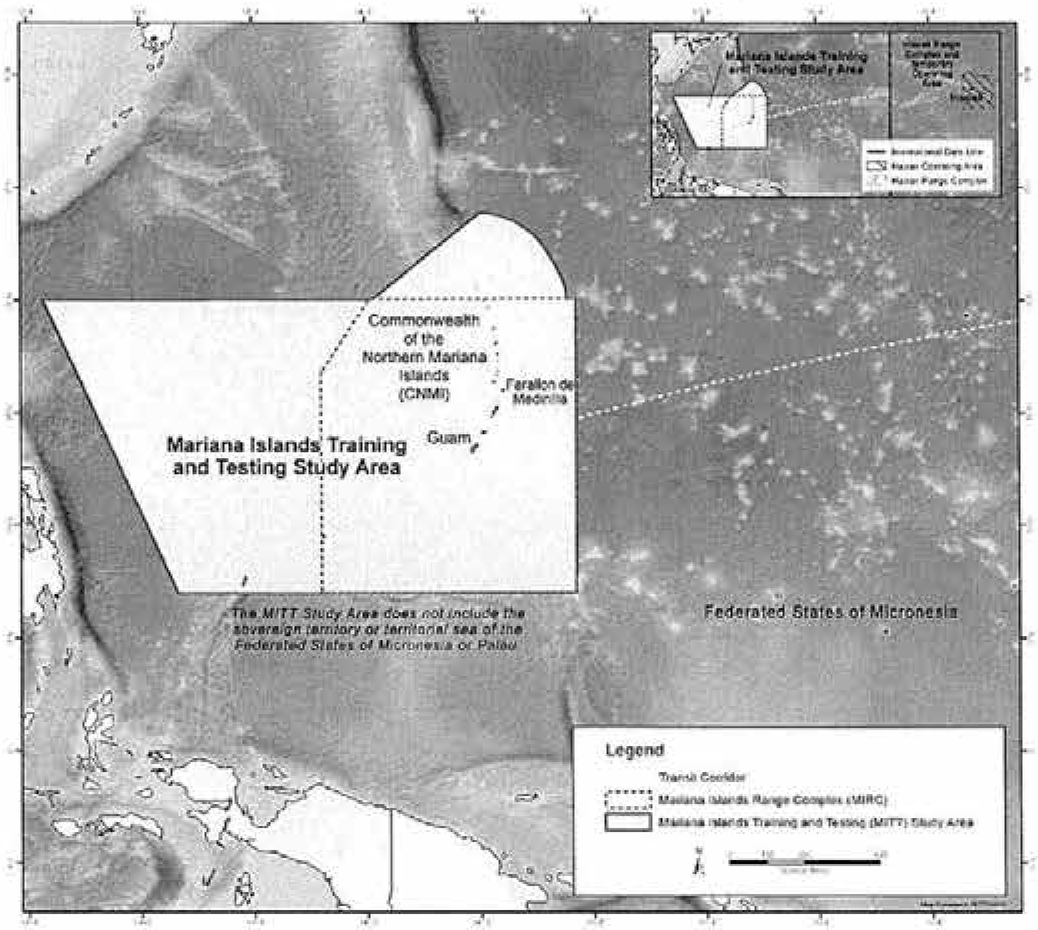
Sincerely,

L. M. FOSTER
By direction

Attachments:
(1) MITT Study Area
(2) ESA-listed Species, Designated Critical Habitat Units, and Candidates for ESA listing on Guam and the Commonwealth of the Northern Mariana Islands

Attachment 1

MITT Study Area



Attachment 2:

ESA-listed Species, Designated Critical Habitat Units, Candidates for ESA listing on Guam and the Commonwealth of the Northern Mariana Islands

Table A-1: ESA-listed Species

Common Name	Scientific Name	ESA Listing Status	Island Occurrence[1]
Plants			
Hayun lagu	*Serianthes nelsonii*	Endangered	Guam, Rota
-	*Osmoxylon mariannense*	Endangered	Rota
-	*Nesogenes rotensis*	Endangered	Rota
Nesting Sea Turtles			
Green sea turtle	*Chelonia mydas*	Threatened	Guam, Rota, Saipan, Tinian
Hawksbill turtle	*Eretmochelys*	Endangered	
Birds			
Nightingale reed warbler	*Acrocephalus luscinia*	Endangered	Saipan
Guam Micronesian kingfisher	*Halcyon cinnamomina cinnamomina*	Endangered	Guam[2]
Mariana crow	*Corvus kubaryi*	Endangered	Guam[2], Rota
Guam rail	*Gallirallus owstoni*	Endangered	Guam[2], Rota[3]
Mariana swiftlet	*Aerodramus bartschi*	Endangered	Guam, Saipan
Mariana common moorhen	*Gallinula chloropus guami*	Endangered	Guam, Rota, Tinian, Saipan
Micronesian megapode	*Megapodius laperouse*	Endangered	Guam, Rota, Tinian, Saipan, FDM
Rota bridled white-eye	*Zosterops rotensis*	Endangered	Rota
Short-tailed albatross	*Phoebastria albatrus*	Endangered	-
Hawaiian petrel	*Pterodroma sandwichensis*	Endangered	-
Newell's shearwater	*Puffinus auricularis*	Threatened	-
Mammals			
Mariana fruit bat	*Pteropus mariannus*	Threatened	Guam, Rota, Tinian, Saipan, FDM

Notes:

1. The Action Area for this consultation will include portions of Guam, Rota, Tinian, and Saipan, and all of Farallon de Medinilla (FDM).
2. Guam Micronesian kingfisher, Guam rail, and Mariana crow are extirpated from Guam.
3. An experimental population of Guam rails was introduced on Rota

Table A-2: Critical Habitat Units

Critical Habitat Unit	Species	Size
Guam National Wildlife Refuge Ritidian Point Unit	Mariana fruit bat, Mariana crow, Guam Micronesian kingfisher	376 acres (152 hectares)
Rota	Mariana crow	6,409 acres (2,594 hectares)
Rota	Rota bridled white-eye	3,958 acres (1,602 hectares)

Table A-3: Candidate Species

Common Name	Scientific Name	Candidate Status
Butterfly Species		
Mariana eight-spot butterfly	*Hypolimnas octocula marianensis*	Re-affirmed on 21 November 2012 (77 FR 69993 70060)
Mariana wandering butterfly	*Vagrans egistina*	
Partulid Snail Species		
Humped tree snail	*Partula gibba*	Re-affirmed on 21 November 2012 (77 FR 69993 70060)
Guam tree snail	*Partula radiolata*	
Fragile tree snail	*Samoana fragilis*	
Mammals		
Pacific sheath-tailed bat	*Emballonura semicaudata*	Re-affirmed on 21 November 2012 (77 FR 69993 70060)

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
Ser N01CE1/1133
27 Aug 12

CAPT Casey J. White
Commander
USCG Sector Guam
PSC 455-Box 176
FPO AP-96540-1056

Dear CAPT White:

SUBJECT: MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT/OVERSEA ENVIRONMENTAL IMPACT STATEMENT (EIS/OEIS) - COOPERATING AGENCY

In accordance with the National Environmental Policy Act (NEPA), the United States (U.S.) Department of the Navy (Navy) is initiating the preparation of an EIS/OEIS to evaluate the potential environmental effects associated with military readiness training and research, development, testing, and evaluation (hereafter referred to as "training and testing") activities that include the use of active sonar and explosives in the MITT EIS/OEIS Study Area. The MITT Study Area includes the existing Mariana Islands Range Complex (MIRC), additional areas on the high seas, and a transit corridor where training and testing activities may occur (see Enclosure 1).

The proposed action is to conduct training and testing activities within the MITT study area. The purpose of the proposed action is to achieve and maintain military readiness to meet the requirements of Title 10 of the U.S. Code, thereby ensuring that the Navy and other Services meet their mission to maintain, train, and equip combat-ready military forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. The proposed action also serves to support force structure changes and emerging and future training and testing associated with new systems within the MITT EIS/OEIS Study Area, thereby ensuring critical military requirements are met.

U.S. Department of Homeland Security

United States Coast Guard

Commander
U. S. Coast Guard
Sector Guam

PSC 455 BOX 176
FPO, AP 96540-1056
Staff Symbol: s
Phone: 671-355-4866
Fax: 671-355-4803
Email: casey.j.white@uscg.mil

5090
10 Oct 2012

MEMORANDUM

From: Casey J. White, CAPT
CG SECTOR Guam (s)

Reply to Attn of: BMC Whitaker
671-355-4866

To: Mr. John Van Name
COMPACFLT Pearl Harbor HI (N01CE1)

Subj: MARIANA ISLANDS TRAINING AND TESTING (MITT) ENVIRONMENTAL IMPACT STATEMENT

Ref: (a) Your memo dated 27 Aug 2012

1. I am in receipt of reference (a) and have reviewed your proposal to extend the study area. Please keep my office informed of your progress in this regard.

2. If I can be of assistance to you, please do not hesitate to contact Sector Guam. My point of contact for this issue is BMC Thomas Whitaker, who can be reached at the number provided above or at Thomas.E.Whitaker@uscg.mil

#

Appendix D: Air Quality Calculations and Record of Non-Applicability

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

This Page Intentionally Left Blank

APPENDIX D AIR QUALITY CALCULATIONS AND RECORD OF NON-APPLICABILITY

This appendix discusses emission factors, calculations, and assumptions used in the air quality analyses presented in the Air Quality section of Chapter 3 (see Section 3.2).

D.1 SURFACE OPERATIONS EMISSIONS

Surface operations are activities associated with vessel movements. Training and testing activities use a variety of marine vessels, including cruisers, destroyers, frigates, carriers, submarines, amphibious vessels, and small boats. These vessels use a variety of propulsion methods, including marine outboard engines, diesel engines, and gas turbines.

Marine Outboard Engines:

The United States Environmental Protection Agency (USEPA) has published emissions factors for air pollutants produced by several types of two-stroke and four-stroke outboard engines. The most conservative emission factors for two-stroke engines of various horsepower are presented in Table D.1-1.

Table D.1-1: Emission Factors for Two Stroke Engines

USEPA Outboard Engine Emissions Factors (grams/hp-hr.)			
NO_x	CO	VOC	SO_x
0.018	0.63	0.25	0.00108

Notes: USEPA = United States Environmental Protection Agency, hp = horsepower, hr. = hour, NO_x = nitrogen oxides, CO = carbon monoxide, VOC = volatile organic compounds, SO_x = sulfur oxides

Source: USEPA 1999, Exhaust Emissions Factors for Non-Road Engine Modeling-Spark Ignition. Report No. NR-010b; Office of Mobile Sources, Assessment and Modeling Division, EPA-R-99-009.

Emissions for surface craft using outboard engines were calculated using USEPA AP-42 factors, and multiplied by the engine horsepower and hours of operation.

$$Emissions = HP \times HR/YR \times EF \times ENG$$

Where:

Emissions = surface craft emissions
HP = horsepower (reflective of a particular load factor/engine power setting)
HR/YR = hours per year
EF = emission factor for specific engine type
ENG = number of engines

To obtain the total criteria pollutant emissions for the Proposed Action, emissions were calculated for each training or testing activity, type of surface vessel, and criteria pollutant. These individual estimates of emissions, in units of tons per year, were then summed by criteria pollutant to obtain the aggregate emissions for surface vessel emissions activities.

Diesel Engines:

Limited data were available for large marine diesel engines. Therefore, USEPA AP-42 emissions factors for industrial reciprocating engines were used to calculate diesel engine emissions. Other sources of vessel emissions factors were previous United States Department of the Navy (Navy) Environmental

Impact Statement (EIS)/Overseas EIS (OEIS) documents (citing JJMA 2001). Diesel was assumed to be the primary fuel to ensure a conservative estimate. Calculation methods similar to those described for Marine Outboard Engines were used to obtain emissions estimates for diesel engines.

$$Emissions = HP \times HR/YR \times EF \times ENG$$

Where:

Emissions = surface craft emissions
HP = horsepower (reflective of a particular load factor/engine power setting)
HR/YR = hours per year
EF = emission factor for specific engine type
ENG = number of engines

Diesel engine emission factors were multiplied by the engine horsepower and annual hours of operation to calculate the pollutant emissions per year.

D.2 AIR OPERATIONS EMISSIONS

Training and testing consists of the activities of various aircraft, including the F/A-18, P-3, SH-60B and other military aircraft. Aircraft operations of concern are those that occur from ground level up to 3,000 feet (ft.) (914 meters [m]) above ground level (AGL). The 3,000 ft. (914 m) AGL ceiling was assumed to be the atmospheric mixing height above which any pollutant generated would not contribute to increased pollutant concentrations at ground level (known as the mixing zone). All pollutant emissions from aircraft generated above 3,000 ft. (914 m) AGL are excluded from analysis for compliance with National Ambient Air Quality Standards. The pollutant emission rate is a function of the aircraft engine's fuel flow rate and efficiency. Emissions for one complete training activity for a particular aircraft are calculated by knowing the specific engine pollutant emission factors for each mode of operation.

For this EIS/OEIS, emission factors for most military engines were obtained from the Navy's Aircraft Environmental Support Office (AESO) memoranda and previous Navy EIS/OEIS documentation (primarily citing the Federal Aviation Administration's Emissions and Dispersion Modeling [EDMS] model). For those aircraft for which engine data were unavailable, an applicable surrogate was used. Using these data, as well as information on activity levels (i.e., number of sorties), pollutant emissions for each aircraft were calculated by applying the equation below.

$$Emissions = TIM \times FF \times EF \times ENG \times CF$$

Where:

Emissions = aircraft emissions (lb.) (for EF in lb./1,000 gallons [gal.] fuel)
TIM = time-in-mode at a specified power setting (hours [hr]./operation)
FF = fuel flow at a specified power setting (gal./hr./engine)
EF = emission factor for specific engine type and power setting (lb. /1,000 gal. of fuel used)
ENG = number of engines on aircraft
CF = conversion factor (0.001)

Table D.2-1 is an example of emission factors for the aircraft engines. The table lists the various engine power modes, time in each mode, fuel flow, and corresponding pollutant emission factors.

Table D.2-1: Emission Factors for Military Aircraft

Aircraft Type	Engine Model	Number of Engines	Time in Mode*, hours	Fuel Flow, lb./hr./engine	Emission Factors, lb./1,000 gallons (gal.) of fuel				
					CO	NOx	VOC	SOx	PM
EA-6B	J52-P-408A (2)	2	3.2	3,195	7.99	5.71	1.09	0.40	12.20
FA-18E/F	F414-GE-400 (2)	2	38.4	5,169	0.72	14.75	0.12	0.40	6.56
P-3	T56-A-14 (4)	4	2.4	1,200	1.82	8.43	0.41	0.40	3.97
SH-60B	T700-GE-401C (2)	2	120	600	6.25	6.40	0.55	0.40	4.20

*Time in Mode = time operating below 3,000 feet during a Joint Expeditionary Exercise

Notes: lb. = pound(s), hr. = hour(s), CO = carbon monoxide, NOx = nitrogen oxides, VOC = volatile organic compounds, SOx = sulfur oxides, PM = particulate matter

D.3 ORDNANCE AND MUNITIONS EMISSIONS

Available emissions factors (AP-42, *Compilation of Air Pollutant Emission Factors*) were used. These factors were then multiplied by the net weight of the explosive and the number of items that were used per year. This calculation provides estimates of annual emissions.

$$Emissions = EXP/YR \times EF \times Net\ Wt$$

Where:

Emissions = ordnance emissions
EXP/YR = explosives, propellants, and pyrotechnics used per year
EF = emissions factor
Net Wt = net weight of explosive

D.4 EMISSIONS FROM VEHICLES AND OTHER EQUIPMENT

Available emissions factors (AP-42, *Compilation of Air Pollutant Emission Factors* and other sources) were used. These factors were then multiplied by the fuel usage for the vehicle or the equipment.

$$Emissions = EF \times fuel\ usage$$

Where:

Emissions = vehicle/equipment emissions
Fuel usage = lb./year
EF = emissions factor

D.5 EMISSIONS ESTIMATES SPREADSHEETS

Tables D.5-1 to D.5-22 presented after the Record of Non-Applicability contain the emission factors and the emissions calculations for aircraft, vessels, ordnance, vehicles and other equipment for training and testing. The emissions are provided in total as well as by geographical jurisdiction (onshore and within state waters, federal waters, and beyond federal waters) for surface vessels and aircraft. Table D.5-23 presents the emissions from activities that will occur in Guam's sulfur oxide non-attainment areas, which are also included for purposes of the conformity analysis.

D.6 RECORD OF NON-APPLICABILITY

The following are the Record of Non-Applicability memorandum (Figure D.6-1), the Navy Record of Non-Applicability (Figure D.6-2) and the Conformity Analysis (Figure D.6-3). The conformity analysis is included in Section 3.2.

MEMORANDUM FOR THE RECORD

From: __________

Subj: Applicability Analyses for Mariana Islands Training and Testing (MITT) Environmental Impact Statement/Overseas Environmental Impact Statement – Operations in State Waters of the Territory of Guam

Ref: 40 C.F.R., 51.853(b)

Encl: (1) Record of Non-Applicability for Mariana Islands Training and Testing in State Waters of the Territory of Guam;

(2) Conformity Analyses for Preferred Alternative Operating Scenario in State Waters of the Territory of Guam

1. Enclosure (1) is a Record of Non-Applicability for those activities associated with Pacific Fleet training and testing activities that are expected to occur annually in Territory of Guam waters. SO_x emissions of the Preferred Alternative are included in Enclosure 2. Comparison of the calculated values in Enclosure 2 with those in reference (b) show that this project is below the *de minimis* levels.

2. If there are any questions or if additional information is needed, please call ________ at ______.

____

Name

Title

Figure D.6-1: Record of Non-Applicability Memorandum

NAVY RECORD OF NON-APPLICABILITY FOR CLEAN AIR ACT CONFORMITY

The Proposed Action falls under the Record of Non-Applicability (RONA) category, and is documented with this RONA.

Proposed Action:

Action Proponents: United States Pacific Fleet
Naval Sea Systems Command
Naval Air Systems Command
Space and Naval Warfare Systems Command
Office of Naval Research

Proposed Action Name: Mariana Islands Training and Testing (MITT) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS)

Proposed Action and Emissions Summary:

Affected Air Basin: Guam Air Basin

Date RONA prepared: ______________________________________

RONA prepared by: Naval Facilities Engineering Command, Pacific

Attainment Area Status and Emissions Evaluation Conclusion:

To the best of my knowledge and belief, the information contained within this General Conformity Applicability Analysis is correct and accurate. By signing this statement, I am in agreement with the finding that the total of all reasonably foreseeable direct and indirect emissions that will result from this action is below the de minimis threshold set forth in 40 C.F.R. 51.853(b). Accordingly, it is my determination that this action conforms to the applicable State Implementation Plan (SIP).

RONA Approval:

Signature: ____________________________________

Name/Rank: ___________________________ Date: _________________

Position: ____________Commanding Officer: __________________ Activity: __________________

Enclosure 1

Figure D.6-2: Record of Non-Applicability Form

Subject: Conformity Analysis for Navy Training and Testing

The MITT EIS/OEIS has been prepared to assess current and future operations in the Mariana Islands EIS/OEIS Study Area. The Study Area includes the territorial waters of Guam. The training and testing operations generally will involve a variety of boats and other watercraft which will be used to support and also perform on water testing operations. Portions of other Navy training and testing events are also conducted within Guam territorial waters. Aircraft overflights and vessel operations during portions of anti-submarine warfare and anti-surface warfare training and testing events would occur within Guam territorial waters.

Table 1 lists the emission sources, their engines, and their fuels that will operate in the non-attainment areas of Guam. This and other engine information were used to calculate the potential emissions of sulfur oxides.

Table 1: List of Emission Sources, Engines, and Fuels

Boat or Source	Fuel	Number of Engines and Engine Size
Cruiser	Distillate Oil	Four – 33,600 hp
Amphibious assault ship	Distillate Oil	Two boilers, two turbines – 70,000 hp total
Amphibious transport dock	Distillate Oil	Two boilers, two turbines – 24,000 hp total
Guided missile frigate	Distillate Oil	Two – 41,000 hp total
Landing craft – utility	Distillate Oil	Two – 680 hp
Landing craft – air cushioned	Distillate Oil	Four – 16,000 hp total
Rigid hull inflatable boat	Gasoline	Two – 300 hp
Combat rubber raiding craft	Gasoline	One – 55 hp
CH-46	Jet Fuel	Two – 1870 hp
CH-53	Jet Fuel	Two – 3925 hp
MH-53	Jet Fuel	Three – 4380 hp
MV-22	Jet Fuel	Two – 6150 hp
UH-1	Jet Fuel	One – 1,100 hp
AH-1	Jet Fuel	Two – 1690 hp
AV-8	Jet Fuel	One – 23,500 pound force
AV-8B	Jet Fuel	One – 23,500 pound force
H-60	Jet Fuel	Two – 1890 hp
SH-60B	Jet Fuel	Two – 1890 hp
C-130	Jet Fuel	Four – 4590 hp
MQ-4C	Jet Fuel	One – 8,917 pound force
Light armored vehicle	Distillate Oil	One – 19.5 hp
Assault Amphibious Vehicle	Distillate Oil	One – 400 hp
High Mobility Multi-Purpose Wheeled Vehicle	Distillate Oil	One – 190 hp
Truck	Distillate Oil	One – 170 hp
Dozer	Distillate Oil	One – 420 hp
Forklift	Distillate Oil	One – 120 hp
Generator	Distillate Oil	One – 120 hp
Reverse Osmosis Water Purification Unit	Distillate Oil	One – 120 hp

Note: hp = horsepower

Figure D.6-3: Conformity Analysis

In addition to the engine information for each vessel, the annual hours of operation for each vessel was needed to estimate the emissions of SO_x. Using the engine and fuel information and proposed hours of operation, the appropriate emission factors were identified from various U.S. Environmental Protection Agency documents for marine engines. These documents included:

1. Draft Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder, EPA420-D-007-001, March 2007.
2. USEPA Memorandum, "Emission Factors for Recreational Marine Diesel Engines," EPA Doc No. EPA420-F-02-044, dated 09 September 2002.
3. Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition EPA 420-P-04-009. April 2004.
4. "Conversion Factors for Hydrocarbon Emission Components" EPA420-R-05-015. December 2005, NR-002c.

For each source, the appropriate emission factor is multiplied by the period of use and the engine size to estimate emissions. Similar methods were applied to calculate aircraft emissions. The emissions of sulfur oxides from all sources were added. Appendix D of the EIS/OEIS contains the information from which these emissions estimates were calculated. The emissions estimates for sulfur oxides for each alternative are provided in Table 2 below.

Table 2: Emissions Estimates for the Preferred Alternative for Training and Testing Activities in the Non-Attainment Areas of Guam

Estimated Annual Air Pollutant Emissions in the Study Area (within 3 nm), Alternative 1			
Emissions by Air Pollutant (TPY)			
		SOx	
No Action Alternative		**172**	
Alternative 1			
Aircraft		9	
Vessels		254	
Ordnance		0	
Other		0	
Alternative 1 Total		**263**	
Change		**91**	
De Minimis Threshold		100	
Exceeds Threshold?		No	

Enclosure 2

Figure D.6-3: Conformity Analysis (continued)

This Page Intentionally Left Blank

Appendix E: Public Participation

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

There are no figures in this section.

This Page Intentionally Left Blank

APPENDIX E PUBLIC PARTICIPATION

This appendix includes information about the public's participation in the development of the Mariana Islands Training and Testing (MITT) Activities Environmental Impact Statement (EIS)/Overseas EIS (OEIS).

E.1 PROJECT WEBSITE

A public website was established specifically for this project: http://www.MITT-EIS.com/. This website address was published in the *Notice of Intent to Prepare an Environmental Impact Statement and Overseas Impact Statement* (Notice of Intent) and has subsequently been re-printed in all newspaper advertisements, agency letters, and public postcards. The Scoping Meeting Fact Sheets and various other materials will be available on the project website throughout the course of the project.

E.2 GENERAL SUMMARY OF THE SCOPING PERIOD

The public scoping period began with the issuance of the Notice of Intent in the *Federal Register* on 16 September 2011. This notice included a project description and scoping meeting dates and locations. The scoping period lasted 60 days, concluding on 7 November 2011. Section E.2.1 describes the United States (U.S.) Department of the Navy's (Navy's) notification efforts during scoping. The scoping period allowed a variety of opportunities for the public to comment on the scope of the EIS/OEIS.

E.2.1 PUBLIC SCOPING NOTIFICATION

The Navy made significant efforts at notifying the public to ensure maximum public participation during the scoping process. A summary of these efforts follows.

E.2.1.1 Scoping Notification Letters

Elected Officials:

U.S. Congressional Delegate, Washington D.C. Office
Guam Office of the Governor
31st Guam Legislature
Village of Agana Heights
Village of Agat
Village of Asan-Maina
Village of Barrigada
Village of Chalan Pago-Ordot
Village of Dededo
Village of Hagåtña
Village of Inarajan
Village of Mangilao
Village of Merizo
Village of MongMong-Toto-Maite
Village of Piti
Village of Santa Rita
Village of Sinajana
Village of Talofofo
Village of Tamuning-Tumon-Harmon
Village of Umatac
Village of Yigo
Village of Yona

13th Rota Municipal Council
Rota Mayor's Office
Saipan Mayor's Office
Tinian Mayor's Office
CNMI House of Representatives
CNMI Public Information and Protocol Office
CNMI Senate

Government Agencies – Federal:
Federal Aviation Administration
National Park Service, War in the Pacific National Historic Park
National Marine Fisheries Service Habitat Division, Guam Office
National Marine Fisheries Service, CNMI Office
U.S. Army Corps of Engineers, Honolulu District
U.S. Coast Guard Sector Guam – Officer in Charge Marine Inspections
U.S. Department of Agriculture, Natural Resource Conservation Service, West Area Office
U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services
U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Institute of Pacific Islands Forestry
U.S. Department of Agriculture, Natural Resources Conservation Service, Saipan Service Center
U.S. Department of the Interior, Office of Insular Affairs
U.S. Environmental Protection Agency, Region 9
U.S. Environmental Protection Agency, Region 9, Pacific Islands Contact Office, Honolulu
U.S. Fish & Wildlife Service
U.S. Fish & Wildlife Service, Guam
U.S. Fish & Wildlife Service, Guam National Wildlife Refuge
U.S. Fish & Wildlife Service, Pacific Islands Fish and Wildlife Office

Government Agencies – Local:
A.B. Won Pat International Airport, Guam
Department of Military Affairs/Guam Air National Guard
Guam Bureau of Statistics and Plans, Coastal Management Program
Guam Chamorro Land Trust Commission
Guam Department of Agriculture
Guam Department of Agriculture, Division of Aquatics and Wildlife Resources
Guam Department of Parks and Recreation, Historic Preservation Office
Guam Environmental Protection Agency
Guam Environmental Protection Agency, Water Resources Management Program
Guam Homeland Security, Office of Civil Defense
Guam Visitors Bureau
Guam Waterworks Authority
CNMI Coastal Resources Management Program
CNMI Department of Community and Cultural Affairs, Historic Preservation Office
CNMI Department of Lands and Natural Resources, Division of Agriculture
CNMI Department of Lands and Natural Resources, Division of Fish and Wildlife
CNMI Department of Lands and Natural Resources, Division of Parks and Recreation
CNMI Department of Public Lands
CNMI Department of Public Safety, Office of the Commissioner

CNMI Department of Public Safety, Tinian Fire Division
CNMI Division of Environmental Quality

Other:
CNMI Northern Marianas College Cooperative, Research, Extension and Education Service
Saipan Chamber of Commerce
Guam Community College
University of Guam
University of Guam Water and Environmental Research Institute

An additional 10 stakeholders were sent a personalized notification letter on 9 September 2011, that offered a briefing. Recipients included:

Congressional Delegate Guam District Office
Congressional Delegate Saipan District Office
Guam Office of the Governor
31st Guam Legislature
Mayors' Council of Guam
Military Integration Management Committee
CNMI Department of Commerce
Guam Chamber of Commerce
Saipan Chamber of Commerce
Tinian Chamber of Commerce

E.2.1.2 Postcard Mailers

On 12 September 2011, postcards announcing the Notice of Intent and providing the scoping meeting dates, locations, and times were mailed to 475 organizations and individuals on the project mailing list, which was compiled from the previous Mariana Islands Range Complex (MIRC) National Environmental Policy Act (NEPA) project mailing lists.

E.2.1.3 Press Releases

Press releases to announce the Notice of Intent were distributed on 9 September 2011.

E.2.1.4 Newspaper Display Advertisements

Advertisements were made to announce the scoping meetings in the following newspapers on the dates indicated below:

Marianas Variety	*Pacific Daily News*	*Saipan Tribune*
9 September 2011	9 September 2011	9 September 2011
21 September 2011	16 September 2011	19 September 2011
27 September 2011	21 September 2011	23 September 2011
28 September 2011	22 September 2011	24 September 2011
29 September 2011	23 September 2011	26 September 2011

E.2.2 Scoping Meetings

Five scoping meetings were held on September 22, 23, 26, 27, and 29 in the villages of Mangilao, Guam; Santa Rita, Guam; Susupe, Saipan; San Jose Village, Tinian; and Songson Village, Rota, respectively. At each scoping meeting, staffers at the welcome station greeted guests and encouraged them to sign in to be added to the project mailing list to receive future notifications. In total, 229 people signed in at the welcome table. The meetings were held in an open house format, presenting informational posters and written information, with Navy staff and project experts available to answer participants' questions. Additionally, a digital voice recorder was available to record participants' oral comments. The interaction during the information sessions was productive and helpful to the Navy.

What is a scoping meeting?

The scoping period determines the extent of the EIS in terms of significant issues. Scoping meetings allow the face-to-face exchange of information and ideas to ensure relevant topics are identified and properly studied and that the Draft EIS is thorough and balanced.

E.2.3 PUBLIC SCOPING COMMENTS

Scoping participants submitted comments in five ways:

- Oral statements at the public meetings (as recorded by the digital voice recorder)
- Written comments at the public meetings
- Written letters (received any time during the public comment period)
- Electronic mail (received any time during the public comment period)
- Comments submitted directly on the project website (received any time during the public comment period)

In total, the Navy received comments from 34 individuals and groups. Because many of the comments addressed more than one issue, 135 total comments resulted. Table E-1 provides a breakdown of areas of concern based on comments received during scoping. The summary following Table E-1 provides an overview of comments and is organized by area of concern.

Table E-1: Public Scoping Comment Summary

Area of Concern	Count	Percent of Total
Proposed Action/Alternatives	9	7
Study Area	7	5
Marine Mammals/Sea Turtles	7	5
Marine Mammal Monitoring	5	4
Fish/Marine Habitat	8	6
Terrestrial/Birds	10	7
Water Quality	5	4
Air Quality	1	1
Noise	2	1
Cultural Resources	5	4
Reefs	3	2
Land Use	5	4
Commercial/Recreational Fishing	6	4
Regional Economy	9	7

Table E-1: Public Scoping Comment Summary (continued)

Area of Concern	Count	Percent of Total
Public Health & Safety	6	4
SONAR/Underwater Explosions	6	4
Marianas Trench National Monument/Piti Marine Preserve Area	3	2
Mitigation	8	6
Cumulative	8	6
Other	21	16
TOTAL	**134**	**99**

E.2.3.1 Proposed Action/Alternatives

Comments in this category included whether NEPA applied in the open ocean, if other training sites were options, and whether some proposed sites in the Study Area could be avoided.

E.2.3.2 Study Area

Participants expressed concerned regarding the larger size of Study Area. Participants expressed confusion between the MIRC Study Area and the new MITT Study Area and why the boundaries have changed.

E.2.3.3 Marine Mammals/Sea Turtles

Participants expressed concern that military activity would drive marine mammals to other locations. Participants expressed concern over impacts from Sound Navigation and Ranging (sonar) and underwater explosives.

E.2.3.4 Marine Mammal Monitoring

Respondents inquired as to whether monitoring was taking place and if it would continue, and generally requested the results of any monitoring that had taken place to date.

E.2.3.5 Fish/Marine Habitat

Concerns in this area were related to potential harm to fish and habitat during military training activities.

E.2.3.6 Terrestrial/Birds

Comments in this category included concerns regarding military training impacts on seabirds on Farallon de Medinilla, general injury of wildlife, monitoring of the Mariana fruit bats/swiftlets/common moorhen, and bird aircraft strike hazards.

E.2.3.7 Water Quality

Water quality comments included general concerns regarding potential contaminants in the water.

E.2.3.8 Air Quality

One respondent noted a general concern regarding the impact of military training on air quality.

E.2.3.9 Noise

Respondents commented on the potential impact of noise on the public, wildlife, and areas outside of military installation boundaries.

E.2.3.10 Cultural Resources

One respondent was concerned about impacts on and access to historical medicinal plants. Other respondents made comments related to the historical resources of the region.

E.2.3.11 Reefs

Participant expressed concern regarding the impact of military training on reefs.

E.2.3.12 Land Use

Land use comments ranged from respondents not wanting the military to use the land at all to concerns regarding overall cumulative effects on land-based resources.

E.2.3.13 Commercial/Recreational Fishing

Comments concerned the limitations placed on fishermen as a result of military activity. One participant suggested that additional military personnel brought to the region should be given a special orientation regarding the local population and resources. Additional comments included concern regarding restrictions to prime fishing areas.

E.2.3.14 Regional Economy

There were several comments regarding regional economic concerns, including questions about the effects on commercial shipping and commercial fishing.

E.2.3.15 Public Health and Safety

Respondents commented on the overall potential cumulative impacts related to public health and safety.

E.2.3.16 SONAR/Underwater Explosions

Concerns were expressed regarding the impact of sonar and underwater explosives on marine mammals and sea turtles.

E.2.3.17 Marianas Trench National Monument/Piti Marine Preserve

One participant questioned whether the Marianas Trench National Monument was included in the Study Area and, if it was, whether special environmental precautions would be taken in the vicinity of the monument.

E.2.3.18 Mitigation

Participants wanted to ensure that mitigations were discussed in the Draft EIS/OEIS and asked for reports of the effectiveness of mitigations put in place as a result of the MIRC Record of Decision. A suggestion was made that a communication line be established between the military and the office of the Mayor of Rota for notification of military exercises at least two weeks ahead of time.

E.2.3.19 Cumulative

Comments in this category expressed concern about the overall impact of military activity in Guam and in overall MITT Study Area.

E.2.3.20 Other

This category of comments related to the desire for the military activities to take place somewhere other than the Mariana Islands, that the documents were not available at the library that had been publicized, issues with use of the project website, concern regarding the way information was conveyed to the public, concern regarding termination of public leases as a result of the Proposed Action, a desire for reporting of the adequacy of Notices to Mariners and Notices to Airmen, excitement regarding their ability to be involved in the NEPA process, and praise to the Navy presenters at the public meetings.

This Page Intentionally Left Blank

Appendix F: Training and Testing Activities Matrices

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

There are no figures in this section.

This Page Intentionally Left Blank

APPENDIX F TRAINING AND TESTING ACTIVITIES MATRICES

F.1 STRESSOR BY TRAINING ACTIVITY

Table F-1: Stressors by Training Activity

Mariana Islands Training Activity	Biological Resources																Physical Resources						Human Resources							
	Acoustic Stressors							Energy Stressors		Physical Stressors				Entanglement Stressors		Ingestion Stressors	Air Quality Stressors		Sediment and Water Quality Stressors											
	Sonar and other active acoustic sources	Explosives	Swimmer Defense airguns	Weapons firing, launch, and impact noise	Aircraft noise	Vessel noise		Electromagnetic	Lasers	Aircraft and Aerial Targets	Vessels and in-water devices	Military Expended Materials	Seafloor Devices	Fiber-optic cables and guidance wires	Parachutes	Military Expended Materials (munitions and other than munitions)	Criteria Pollutants	Hazardous Air Pollutants	Explosives and explosive byproducts	Metals	Chemicals other than explosives	Other Materials	Acoustics[1]	Physical Disturbance[1]	Accessibility[2]	Airborne Acoustics[2]	Physical Disturbance and Strikes[2]	Underwater Energy[3]	In-Air Energy[3]	Physical Interactions[3]
ANTI-AIR WARFARE (AAW)																														
Air Combat Maneuver (ACM)						✓				✓						✓	✓	✓		✓		✓	✓			✓	✓			
Air Defense Exercise (ADEX)						✓				✓	✓						✓	✓								✓	✓			
Air Intercept Control (AIC) Medium-Caliber**						✓											✓	✓	✓							✓	✓			
Gunnery Exercise (Air-to-Air) Medium-Caliber				✓	✓	✓				✓		✓				✓	✓	✓		✓				✓	✓	✓	✓			✓
Missile Exercise (Air-to-Air)				✓		✓				✓		✓			✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓			✓
Gunnery Exercise (Surface-to-Air) Large-Caliber**				✓	✓	✓				✓	✓	✓				✓	✓	✓	✓	✓				✓	✓	✓	✓			✓
Gunnery Exercise (Surface-to-Air) Medium-Caliber**				✓	✓	✓				✓	✓	✓				✓	✓	✓	✓	✓				✓	✓	✓	✓			✓
Missile Exercise (Surface-to-Air)				✓		✓				✓	✓	✓				✓	✓	✓	✓	✓	✓			✓	✓	✓	✓			✓
STRIKE WARFARE (STW)																														
Bombing Exercise (Air-to-Ground)						✓				✓		✓					✓	✓		✓			✓	✓		✓				
Gunnery Exercise (Air-to-Ground)						✓				✓		✓					✓	✓		✓			✓	✓		✓				
Missile Exercise MISSILEX						✓				✓		✓					✓	✓		✓			✓	✓		✓				
Combat Search and Rescue						✓				✓		✓														✓	✓			
AMPHIBIOUS WARFARE (AMW)																														
Naval Surface Fire Support Exercise – Land-Based Target					✓						✓						✓	✓							✓	✓				✓
Amphibious Rehearsal, No Landing – Marine Air Ground Task Force**						✓				✓	✓						✓	✓						✓	✓		✓			✓
Amphibious Assault						✓				✓	✓						✓	✓						✓	✓		✓			✓
Amphibious Raid											✓						✓	✓						✓	✓		✓			✓
Urban Warfare Training					✓	✓												✓		✓	✓	✓				✓	✓			

Table F-1: Stressors by Training Activity (continued)

Mariana Islands Training Activity	Biological Resources																Physical Resources						Human Resources							
	Acoustic Stressors							Energy Stressors		Physical Stressors				Entanglement Stressors		Ingestion Stressors	Air Quality Stressors		Sediment and Water Quality Stressors											
	Sonar and other active acoustic sources	Explosives	Swimmer Defense airguns	Weapons firing, launch, and impact noise	Aircraft noise	Vessel noise		Electromagnetic	Lasers	Aircraft and Aerial Targets	Vessels and in-water devices	Military Expended Materials	Seafloor Devices	Fiber-optic cables and guidance wires	Parachutes	Military Expended Materials (munitions and other than munitions)	Criteria Pollutants	Hazardous Air Pollutants	Explosives and explosive byproducts	Metals	Chemicals other than explosives	Other Materials	Acoustics[1]	Physical Disturbance[1]	Accessibility[2]	Airborne Acoustics[2]	Physical Disturbance and Strikes[2]	Underwater Energy[3]	In-Air Energy[3]	Physical Interactions[3]
AMPHIBIOUS WARFARE (AMW) (continued)																														
Noncombatant Evacuation Operation					✓	✓					✓							✓		✓	✓	✓				✓	✓			
Humanitarian Assistance/Disaster Relief Operations						✓				✓	✓						✓	✓						✓	✓		✓			✓
Unmanned Aerial Vehicle – Intelligence, Surveillance, and Reconnaissance**						✓											✓	✓	✓							✓				
ANTI-SURFACE WARFARE (ASUW)																														
Gunnery Exercise (Air-to-Surface) – Small-Caliber						✓				✓		✓				✓	✓	✓		✓				✓	✓	✓	✓			✓
Gunnery Exercise (Air-to-Surface) – Medium-Caliber			✓			✓				✓	✓	✓				✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓
Missile Exercise (Air-to-Surface) Rocket**			✓			✓				✓	✓	✓				✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Missile Exercise (Air-to-Surface) MISSILEX			✓			✓				✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓
Laser Targeting (at sea)						✓				✓	✓						✓	✓							✓		✓		✓	✓
Bombing Exercise (Air-to-Surface)			✓			✓				✓		✓				✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓
Torpedo Exercise (Submarine-to-Surface)**	✓		✓			✓					✓	✓		✓									✓	✓	✓		✓	✓		✓
Missile Exercise (Surface-to-Surface)**			✓		✓	✓					✓	✓				✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
Gunnery Exercise (Surface-to-Surface) Ship – Large-Caliber			✓		✓	✓					✓	✓				✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓
Gunnery Exercise (Surface-to-Surface) Ship – Small- and Medium-Caliber			✓		✓	✓					✓	✓				✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓
Sinking Exercise (SINKEX)		✓	✓		✓	✓				✓	✓	✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
Gunnery Exercise (Surface-to-Surface) Boat – Small- and Medium-Caliber**					✓	✓					✓	✓				✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓
Maritime Security Operations (MSO)						✓				✓	✓	✓				✓	✓	✓							✓	✓	✓			✓

Table F-1: Stressors by Training Activity (continued)

Mariana Islands Training Activity	Biological Resources																Physical Resources						Human Resources							
	Acoustic Stressors							Energy Stressors		Physical Stressors				Entanglement Stressors		Ingestion Stressors	Air Quality Stressors		Sediment and Water Quality Stressors											
	Sonar and other active acoustic sources	Explosives	Swimmer Defense airguns	Weapons firing, launch, and impact noise	Aircraft noise	Vessel noise		Electromagnetic	Lasers	Aircraft and Aerial Targets	Vessels and in-water devices	Military Expended Materials	Seafloor Devices	Fiber-optic cables and guidance wires	Parachutes	Military Expended Materials (munitions and other than munitions)	Criteria Pollutants	Hazardous Air Pollutants	Explosives and explosive byproducts	Metals	Chemicals other than explosives	Other Materials	Acoustics[1]	Physical Disturbance[1]	Accessibility[2]	Airborne Acoustics[2]	Physical Disturbance and Strikes[2]	Underwater Energy[3]	In-Air Energy[3]	Physical Interactions[3]
ANTI-SUBMARINE WARFARE (ASW)																														
Tracking Exercise – Helicopter	✓					✓				✓	✓	✓			✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓
Torpedo Exercise – Helicopter	✓					✓				✓	✓	✓			✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓
Tracking Exercise – Maritime Patrol Advanced Extended Echo Ranging Sonobuoys	✓					✓				✓	✓	✓			✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓
Tracking Exercise – Maritime Patrol Aircraft	✓					✓				✓	✓	✓			✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓
Torpedo Exercise – Maritime Patrol Aircraft	✓					✓				✓	✓	✓			✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓
Tracking Exercise – Surface	✓					✓					✓	✓					✓	✓						✓	✓		✓	✓		✓
Torpedo Exercise – Surface	✓					✓					✓	✓					✓	✓						✓	✓		✓	✓		✓
Tracking Exercise – Submarine	✓					✓				✓	✓	✓		✓						✓				✓			✓	✓		✓
Torpedo Exercise – Submarine	✓					✓				✓	✓	✓		✓						✓				✓			✓	✓		✓
MAJOR TRAINING EVENTS																														
Joint Expeditionary Exercise	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Joint Multi-Strike Group Exercise	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fleet Strike Group Exercise*	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Integrated Anti-Submarine Warfare Exercise*	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Ship Squadron Anti-Submarine Warfare Exercise*	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Marine Air Ground Task Force Exercise (Amphibious) – Battalion	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Special Purpose Marine Air Ground Task Force Exercise	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Urban Warfare Exercise					✓	✓												✓	✓	✓	✓					✓	✓			

Table F-1: Stressors by Training Activity (continued)

Mariana Islands Training Activity	Biological Resources																Physical Resources						Human Resources							
	Acoustic Stressors							Energy Stressors		Physical Stressors				Entanglement Stressors		Ingestion Stressors	Air Quality Stressors		Sediment and Water Quality Stressors											
	Sonar and other active acoustic sources	Explosives	Swimmer Defense airguns	Weapons firing, launch, and impact noise	Aircraft noise	Vessel noise		Electromagnetic	Lasers	Aircraft and Aerial Targets	Vessels and in-water devices	Military Expended Materials	Seafloor Devices	Fiber-optic cables and guidance wires	Parachutes	Military Expended Materials (munitions and other than munitions)	Criteria Pollutants	Hazardous Air Pollutants	Explosives and explosive byproducts	Metals	Chemicals other than explosives	Other Materials	Acoustics[1]	Physical Disturbance[1]	Accessibility[2]	Airborne Acoustics[2]	Physical Disturbance and Strikes[2]	Underwater Energy[3]	In-Air Energy[3]	Physical Interactions[3]
ELECTRONIC WARFARE (EW)																														
Electronic Warfare Operations (EW Ops)						✓				✓	✓						✓	✓							✓	✓	✓			✓
Counter Targeting Flare Exercise – Aircraft						✓				✓						✓	✓	✓		✓		✓		✓	✓	✓	✓			✓
Counter Targeting Chaff Exercise – Ship						✓					✓					✓	✓	✓				✓			✓					✓
Counter Targeting Chaff Exercise – Aircraft						✓				✓						✓	✓	✓				✓				✓				✓
MINE WARFARE (MIW)																														
Civilian Port Defense**	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Mine Laying					✓	✓				✓		✓					✓	✓		✓				✓	✓	✓	✓			✓
Mine Neutralization – Explosive Ordnance Disposal (EOD)						✓				✓	✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓		✓
Limpet Mine Neutralization System/Shock Wave Generator**																✓				✓				✓	✓	✓	✓	✓		✓
Submarine Mine Exercise**											✓	✓	✓															✓		✓
Airborne Mine Countermeasure – Mine Detection	✓				✓				✓		✓		✓				✓	✓								✓	✓	✓		✓
Mine Countermeasure Exercise (MCM) – Towed Sonar**	✓					✓			✓		✓		✓				✓	✓							✓			✓		✓
Mine Countermeasure Exercise – Surface (SMCMEX) Sonar**	✓					✓					✓		✓				✓	✓							✓			✓		✓
Mine Neutralization – Remotely Operated Vehicle Sonar**						✓				✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓
Mine Countermeasure (MCM) – Towed Mine Detection**	✓					✓				✓	✓		✓				✓	✓						✓	✓	✓	✓	✓	✓	✓

Table F-1: Stressors by Training Activity (continued)

Mariana Islands Training Activity	Biological Resources																Physical Resources						Human Resources							
	Acoustic Stressors							Energy Stressors		Physical Stressors				Entanglement Stressors		Ingestion Stressors	Air Quality Stressors		Sediment and Water Quality Stressors											
	Sonar and other active acoustic sources	Explosives	Swimmer Defense airguns	Weapons firing, launch, and impact noise	Aircraft noise	Vessel noise		Electromagnetic	Lasers	Aircraft and Aerial Targets	Vessels and in-water devices	Military Expended Materials	Seafloor Devices	Fiber-optic cables and guidance wires	Parachutes	Military Expended Materials (munitions and other than munitions)	Criteria Pollutants	Hazardous Air Pollutants	Explosives and explosive byproducts	Metals	Chemicals other than explosives	Other Materials	Acoustics[1]	Physical Disturbance[1]	Accessibility[2]	Airborne Acoustics[2]	Physical Disturbance and Strikes[2]	Underwater Energy[3]	In-Air Energy[3]	Physical Interactions[3]
NAVAL SPECIAL WARFARE (NSW)																														
Personnel Insertion/Extraction (Non-submarine)											✓																			
Parachute Insertion						✓				✓					✓		✓	✓	✓				✓			✓	✓			
Embassy Reinforcement						✓		✓	✓									✓		✓	✓	✓				✓	✓			
Direct Action (Combat Close Quarters)						✓		✓	✓									✓		✓	✓	✓	✓	✓		✓	✓			
Direct Action (Breaching)						✓		✓	✓									✓		✓	✓	✓	✓	✓			✓	✓		
Direct Action (Tactical Air Control)								✓																						
Underwater Demolition Qualification/Certification			✓									✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓		✓
Intelligence, Surveillance, Reconnaissance (ISR)																														
Urban Warfare Training					✓	✓												✓		✓	✓	✓				✓	✓			
Underwater Survey						✓																								

Table F-1: Stressors by Training Activity (continued)

Mariana Islands Training Activity	Biological Resources																Physical Resources						Human Resources							
	Acoustic Stressors							Energy Stressors		Physical Stressors				Entanglement Stressors		Ingestion Stressors	Air Quality Stressors		Sediment and Water Quality Stressors											
	Sonar and other active acoustic sources	Explosives	Swimmer Defense airguns	Weapons firing, launch, and impact noise	Aircraft noise	Vessel noise		Electromagnetic	Lasers	Aircraft and Aerial Targets	Vessels and in-water devices	Military Expended Materials	Seafloor Devices	Fiber-optic cables and guidance wires	Parachutes	Military Expended Materials (munitions and other than munitions)	Criteria Pollutants	Hazardous Air Pollutants	Explosives and explosive byproducts	Metals	Chemicals other than explosives	Other Materials	Acoustics[1]	Physical Disturbance[1]	Accessibility[2]	Airborne Acoustics[2]	Physical Disturbance and Strikes[2]	Underwater Energy[3]	In-Air Energy[3]	Physical Interactions[3]
OTHER TRAINING EXERCISES																														
Surface Ship Sonar Maintenance**	✓					✓					✓																	✓		
Submarine Sonar Maintenance**	✓										✓																	✓		
Small Boat Attack**					✓	✓					✓					✓	✓	✓		✓										
Submarine Navigation**	✓										✓																✓	✓		✓
Search and Rescue At Sea**						✓				✓		✓														✓	✓			
Precision Anchoring**						✓					✓		✓				✓	✓			✓	✓		✓	✓		✓			✓
Maneuver (Convoy, Land Navigation)																	✓	✓	✓					✓			✓			✓
Water Purification**																						✓								
Field Training Exercise						✓												✓		✓	✓	✓				✓	✓			
Force Protection						✓												✓	✓	✓	✓					✓	✓			
Anti-Terrorism						✓												✓	✓	✓	✓					✓	✓			
Seize Airfield						✓												✓	✓	✓	✓					✓	✓			
Airfield Expeditionary						✓												✓	✓	✓	✓					✓	✓			
Unmanned Aerial Vehicle Operation**						✓											✓	✓								✓				
Land Demolitions (Improvised Explosive Device Discovery/Disposal)																		✓												
Land Demolitions (Unexploded Ordnance) Discovery/Disposal					✓													✓	✓	✓	✓	✓				✓				

[1] Cultural resources stressor
[2] Socioeconomics stressor
[3] Public health and safety stressor
* Alternative 2 only
** Alternative 1 and Alternative 2 only
Note: A check indicates events that take place for all alternatives.

F.2 STRESSOR BY TESTING ACTIVITY

Table F-2: Stressors by Testing Activity

Mariana Islands Testing Activity	Biological Resources																Physical Resources						Human Resources							
	Acoustic Stressors							Energy Stressors		Physical Stressors				Entanglement Stressors		Ingestion Stressors	Air Quality Stressors		Sediment and Water Quality Stressors											
	Sonar and other active acoustic sources	Explosives	Swimmer Defense airguns	Weapons firing, launch, and impact noise	Aircraft noise	Vessel noise		Electromagnetic	Lasers	Aircraft and Aerial Targets	Vessels and in-water devices	Military Expended Materials	Seafloor Devices	Fiber-optic cables and guidance wires	Parachutes	Military Expended Materials (munitions and other than munitions)	Criteria Pollutants	Hazardous Air Pollutants	Explosives and explosive byproducts	Metals	Chemicals other than explosives	Other Materials	Acoustics[1]	Physical Disturbance[1]	Accessibility[2]	Airborne Acoustics[2]	Physical Disturbance and Strikes[2]	Underwater Energy[3]	In-Air Energy[3]	Physical Interactions[3]
NAVAL AIR SYSTEMS COMMAND																														
ANTI-SURFACE WARFARE (ASUW)																														
Air-to-Surface Missile Test**			✓			✓				✓		✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
ANTI-SUBMARINE WARFARE (ASW)																														
Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft (Sonobuoys)**	✓		✓			✓				✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Anti-Submarine Warfare Torpedo Test**	✓					✓				✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓
Broad Area Maritime Surveillance (BAMS) Testing - MQ-4C Triton**	✓					✓				✓	✓	✓			✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓
ELECTRONIC WARFARE (EW)																														
Flare Test**										✓						✓	✓	✓		✓		✓		✓	✓	✓	✓			✓
NAVAL SEA SYSTEMS COMMAND																														
LIFE CYCLE ACTIVITIES																														
Ship Signature Testing**	✓					✓					✓						✓	✓									✓	✓		✓
ANTI-SURFACE WARFARE/ANTI-SUBMARINE WARFARE TESTING																														
Kinetic Energy Weapon Testing**				✓		✓					✓	✓					✓	✓	✓	✓	✓			✓	✓	✓	✓			✓
Torpedo Testing**	✓	✓				✓				✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Countermeasure Testing **	✓					✓					✓	✓			✓	✓	✓	✓						✓			✓	✓		✓
At-sea Sonar Testing**	✓					✓					✓						✓	✓									✓	✓		✓
SHIPBOARD PROTECTION SYSTEMS AND SWIMMER DEFENSE TESTING																														
Pierside Integrated Swimmer Defense**	✓	✓	✓								✓		✓											✓			✓	✓		✓
NEW SHIP CONSTRUCTION																														
ASW Mission Package Testing**	✓				✓	✓				✓	✓	✓			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
MCM Mission Package Testing**	✓	✓			✓	✓				✓	✓		✓			✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓
ASUW Mission Package Testing**		✓	✓	✓		✓				✓		✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
OFFICE OF NAVAL RESEARCH																														
North Pacific Acoustic Lab Philippine Sea 2018–19 Experiment (Deep Water)		✓									✓		✓																	

[1] Cultural resources stressor, [2] Socioeconomics stressor, [3] Public health and safety stressor, ** Alternative 1 and Alternative 2 only, Note: A check indicates events that take place for all alternatives.

F.3 STRESSORS BY RESOURCE

Table F-3: Stressors by Resource

Stressors vs. Resources		Biological Resources																					Physical Resources						Human Resources						
		Acoustic Stressors									Energy Stressors		Physical Stressors						Entangleme nt Stressors		Ingestion Stressors	Invasive Species	Air Quality Stressors		Sediment and Water Quality Stressors										
		Sonar and other active acoustic sources	Explosives	Swimmer Defense airguns	Weapons firing, launch, and impact noise	Aircraft noise	Vessel noise				Electromagnetic	Lasers	Aircraft and Aerial Targets	Vessels and in-water devices	Military Expended Materials	Seafloor Devices	Ground Disturbance	Wildfires	Fiber –optic cables and guidance wires	Parachutes	Military Expended Materials (munitions and other than munitions)	Habitat, Prey availability, Invasive Species Introductions at FDM	Criteria Pollutants	Hazardous Air Pollutants	Explosives and explosive byproducts	Metals	Chemicals other than explosives	Other Materials	Acoustics	Physical Disturbance	Accessibility	Airborne Acoustics	Physical Disturbance and Strikes	Underwater Energy	Physical Interactions
Physical	Sediments and Water Quality																								✓	✓	✓	✓							
	Air Quality																						✓	✓											
Biological	Marine Habitats		✓											✓	✓	✓																			
	Marine Mammals	✓	✓	✓	✓	✓	✓				✓			✓	✓	✓			✓	✓	✓				✓	✓	✓	✓							
	Sea Turtles	✓	✓	✓	✓	✓	✓				✓			✓	✓	✓			✓	✓	✓				✓	✓	✓	✓							
	Seabirds and Shorebirds	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓		✓	✓			✓														
	Marine Vegetation		✓											✓	✓	✓									✓	✓	✓	✓							
	Marine Invertebrates	✓	✓	✓	✓	✓	✓							✓	✓	✓			✓	✓	✓				✓	✓	✓	✓							
	Fish	✓	✓	✓	✓	✓	✓				✓			✓	✓	✓			✓	✓	✓				✓	✓	✓	✓							
	Terrestrial				✓		✓						✓		✓		✓	✓				✓													
Human	Cultural Resources			✓											✓	✓	✓												✓	✓					
	Socioeconomic Resources						✓							✓	✓	✓	✓														✓	✓	✓		
	Public Health and Safety	✓	✓	✓	✓		✓					✓	✓	✓	✓																			✓	✓

Appendix G: Statistical Probability Analysis for Estimating Direct Strike Impact and Number of Potential Exposures

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

There are no figures in this section.

This Page Intentionally Left Blank

APPENDIX G STATISTICAL PROBABILITY ANALYSIS FOR ESTIMATING DIRECT STRIKE IMPACT AND NUMBER OF POTENTIAL EXPOSURES

This appendix discusses the methods and results for calculating the probability of a direct strike of an animal from any military items from the proposed training and testing activities falling toward (or directed at) the sea surface. For the purposes of this appendix, military items include non-explosive practice munitions (e.g., rounds from shipboard small-arms live-fire training), sonobuoys, acoustic countermeasures, and targets. Only marine mammals and sea turtles will be analyzed using these methods because animal densities are necessary to complete the calculations, and density estimates are currently only available for marine mammals and sea turtles within the Mariana Islands Training and Testing (MITT) Study Area (Study Area). Furthermore, the analysis conducted here does not account for explosive munitions because impacts from explosives are analyzed within the United States (U.S.) Department of the Navy (Navy) Acoustic Effects Model.

G.1 DIRECT IMPACT ANALYSIS

A statistical probability was calculated to estimate the impact probability (P) and number of exposures (T) associated with direct impact of military items on marine animals on the sea surface within the specified training or testing area (R) in which the activities are occurring. The statistical probability analysis is based on probability theory and modified Venn diagrams with rectangular "footprint" areas for the individual animal (A) and total impact (I) inscribed inside the training or testing area (R). The analysis assumes: (1) that all animals would be at or near the surface 100 percent of the time, when in fact, marine mammals spend the majority of their time underwater, and (2) that the animals are stationary, which does not account for any movement or any potential avoidance of the training or testing activity.

1. A = length*width, where the individual animal's width (breadth) is assumed to be 20 percent of its length for marine mammals and 112 percent of its length for sea turtles. This product for A is multiplied by the number of animals N_a in the specified training or testing area (i.e., product of the highest average seasonal animal density [D] and training or testing area [R]: N_a = D*R) to obtain the total animal footprint area (A*N_a = A*D*R) in the training or testing area. As a worst case scenario, the total animal footprint area is calculated for the species with the highest average seasonal density in the training or testing area with the highest use of military items within the entire Study Area.

2. I = N_{mun}*length*diameter, where N_{mun} = total annual number of military items for each type, and "length" and "diameter" refer to the individual military equipment dimensions. For each type, the individual impact footprint area is multiplied by the total annual number of military items to obtain the type-specific impact footprint area (I = N_{mun}*length*diameter). Each training or testing activity uses one or more different types of military items, each with a specific number and dimensions, and several training and testing activities occur in a given year. When integrating over the number of military items types for the given activity (and then over the number of activities in a year), these calculations are repeated (accounting for differences in dimensions and numbers) for all military items types used, to obtain the type-specific impact footprint area (I). These impact footprint areas are summed over all military items types for the given activity, and then summed (integrated) over all activities to obtain the total impact footprint area resulting from all activities occurring in the training or testing area in a given year.

As a worst case scenario, the total impact footprint area is calculated for the training or testing area with the highest use of military items within the entire Study Area.

Though marine mammals and sea turtles are not randomly distributed in the environment, a random point calculation was chosen due to the intensive data needs that would be required for a calculation that incorporated more detailed information on an animal's or military item's spatial occurrence.

The analysis is expected to provide an overestimation of the probability of a strike for the following reasons: (1) it calculates the probability of a single military item (of all the items expended over the course of the year) hitting a single animal at its species' highest seasonal density, (2) it does not take into account the possibility that an animal may avoid military activities, (3) it does not take into account the possibility that an animal may not be at the water surface, (4) it does not take into account that most projectiles fired during training and testing activities are fired at targets, and so only a very small portion of those projectiles that miss the target would hit the water with their maximum velocity and force, and (5) it does not quantitatively take into account the Navy avoiding animals that are sighted through the implementation of mitigation measures.

The likelihood of an impact is calculated as the probability (P) that the animal footprint (A) and the impact footprint (I) will intersect within the training or testing area (R). This is calculated as the area ratio A/R or I/R, respectively. Note that A (referring to an **individual** animal footprint) and I (referring to the impact footprint resulting from the **total** number of military items N_{mun}) are the relevant quantities used in the following calculations of single-animal impact probability [P], which is then multiplied by the number of animals to obtain the number of exposures (T). The probability that the random point in the training or testing area is within both types of footprints (i.e., A and I) depends on the degree of overlap of A and I. The probability that I overlaps A is calculated by adding a buffer distance around A based on one-half of the impact area (i.e., 0.5*I), such that an impact (center) occurring anywhere within the combined (overlapping) area would impact the animal. Thus, if L_i and W_i are the length and width of the impact footprint such that $L_i*W_i = 0.5*I$ and $W_i/L_i = L_a/W_a$ (i.e., similar geometry between the animal footprint and impact footprint), and if L_a and W_a are the length and width (breadth) of the individual animal such that $L_a*W_a = A$ (= individual animal footprint area), then, assuming a purely static, rectangular scenario (Scenario 1), the total area $A_{tot} = (L_a + 2*L_i)*(W_a + 2*W_i)$, and the buffer area $A_{buffer} = A_{tot} – L_a*W_a$.

Four scenarios were examined with respect to defining and setting up the overlapping combined areas of A and I:

1. **Scenario 1:** Purely static, rectangular scenario. Impact is assumed to be static (i.e., direct impact effects only; non-dynamic; no explosions or scattering of military items after the initial impact). Hence the impact footprint area (I) is assumed to be rectangular and given by the product of military items length and width (multiplied by the number of military items). $A_{tot} = (L_a + 2*L_i)*(W_a + 2*W_i)$ and $A_{buffer} = A_{tot} – L_a*W_a$.

2. **Scenario 2:** Dynamic scenario with end-on collision, in which the length of the impact footprint (Li) is enhanced by Rn = 5 military items lengths to reflect forward momentum. $A_{tot} = (L_a + (1 + R_n)*L_i)*(W_a + 2*W_i)$ and $A_{buffer} = A_{tot} – L_a*W_a$.

3. **Scenario 3:** Dynamic scenario with broadside collision, in which the width of the impact footprint (W_i) is enhanced by R_n = 5 military items lengths to reflect forward momentum. Atot = $(L_a + 2*W_i)*(W_a + (1 + R_n)*L_i)$ and $A_{buffer} = A_{tot} – L_a*W_a$.

4. **Scenario 4:** Purely static, radial scenario, in which the rectangular animal and impact footprints are replaced with circular footprints while conserving area. Define the radius (R_a) of the circular individual animal footprint such that $\pi * R_a^2 = L_a * W_a$, and define the radius (R_i) of the circular impact footprint such that $\pi * R_i^2 = 0.5 * L_i * W_i = 0.5 * I$. Then $A_{tot} = \pi * (R_a + R_i)^2$ and $A_{buffer} = A_{tot} - \pi * R_a^2$ (where $\pi = 3.1415927$).

Static impacts (Scenarios 1 and 4) assume no additional areal coverage effects of scattered military items beyond the initial impact. For dynamic impacts (Scenarios 2 and 3), the distance of any scattered military items must be considered by increasing the length (Scenario 2) or width (Scenario 3), depending on orientation (broadside versus end-on collision), of the impact footprint to account for the forward horizontal momentum of the falling object. Forward momentum typically accounts for five object lengths, resulting in a corresponding increase in impact area. Significantly different values may result from these two types of orientation. Both of these types of collision conditions can be calculated each with 50 percent likelihood (i.e., equal weighting between Scenarios 2 and 3, to average these potentially different values).

Impact probability P is the probability of impacting one animal with the given number, type, and dimensions of all military items used in training or testing activities occurring in the area per year, and is given by the ratio of total area (A_{tot}) to training or testing area (R): $P = A_{tot}/R$. Number of exposures is $T = N*P = N*A_{tot}/R$, where N = number of animals in the training or testing area per year (given as the product of the animal density [D] and range size [R]). Thus, $N = D*R$ and hence $T = N*P = N*A_{tot}/R = D*A_{tot}$. Using this procedure, P and T were calculated for each of the four scenarios, for Endangered Species Act (ESA)-listed marine mammals and the marine mammal and sea turtle species with the highest average seasonal density (used as the annual density value) and for each military item type. The scenario -specific P and T values were averaged over the four scenarios (using equal weighting) to obtain a single scenario -averaged annual estimate of P and T.

G.2 Parameters for Analysis

Impact probabilities (P) and number of exposures (T) were estimated by the analysis for the following parameters:

1. **Three proposed alternatives:** No Action Alternative, Alternative 1, and Alternative 2. Animal densities, animal dimensions, and military item dimensions are the same for the three alternatives.

2. **Training or Testing Area:** The Mariana Islands Training and Testing (MITT) Study Area (Study Area) is an area of 1,723,577.4 square kilometers. For the sea turtle analysis, the Study Area was split into the Nearshore Area (Study Area Shallower than 200 meters [m]), and the Open Ocean (Study Area deeper than 200 m). These two training areas were chosen because there is a higher density of sea turtles in nearshore areas then in the open ocean.

3. The following types of munitions or other items:
    a) **Small-caliber projectiles:** up to and including 0.50 caliber rounds
    b) **Medium-caliber projectiles:** larger than 0.50 caliber rounds but smaller than 57-millimeters (mm) projectiles
    c) **Large-caliber projectiles:** includes projectiles greater than or equal to a 57 mm projectile
    d) **Missiles:** includes rockets and jet-propelled munitions

e) **Bombs:** non-explosive practice bombs and mine shapes, ranging from 10 to 2,000 pounds
f) **Torpedoes:** includes aircraft deployed torpedoes
g) **Sonobuoys:** includes aircraft deployed sonobuoys

4. **Animal species of interest:** The nine species of ESA-listed marine mammals (Humpback Whale [*Megaptera novaeangliae*], Blue Whale [*Balaenoptera musculus*], Fin Whale [*Balaenoptera physalus*], Sei Whale [*Balaenoptera borealis*], Sperm Whale [*Physeter macrocephalus*], North Pacific right whale [*Eubalaena japonica*], Hawaiian monk seal [*Monachus schauinslandi*], Dugong [*Dugong dugon*]), and the non-ESA listed marine mammal species with the highest average seasonal density (Pantropical spotted dolphin) in the Study Area. Three of the nine ESA-listed marine mammals are not expected to occur in the Study Area, and therefore were not analyzed further in this appendix (North Pacific right whale [*Eubalaena japonica*], Hawaiian monk seal [*Monachus schauinslandi*], Dugong [*Dugong dugon*]). The five sea turtle species of interest are the Green Sea Turtle (*Chelonia mydas*), the Hawksbill Sea Turtle (*Eretmochelys imbricata*), the Loggerhead Sea Turtle (*Caretta caretta*), the Olive Ridley Sea Turtle (*Lepidochelys olivacea*), and the Leatherback Sea Turtle (*Dermochelys coriacea*).

G.3 INPUT DATA

Input data for the direct strike analysis include animal species likely to be in the area and military items proposed for use under each of the three alternatives. Animal species data include: (1) species identification and status (i.e., threatened, endangered, or neither), (2) highest average seasonal density estimate for the species of interest, and (3) adult animal dimensions (length and width) for the species with the highest density. The animal's dimensions are used to calculate individual animal footprint areas (A = length*width), and animal densities are used to calculate the number of exposures (T) from the impact probability (P): T = N*P. Military items data include: (1) military items category (e.g., projectile, bomb, rocket, target), (2) military items dimensions (length and width), and (3) total number of military items used annually.

Military items input data, specifically the quantity (e.g., numbers of guns, bombs, and rockets), are different in magnitude among the three proposed alternatives (No Action Alternative, Alternative 1, and Alternative 2). All animal species input data, the military items identification and category, and military items dimensions, are the same for the three alternatives, only the quantities (i.e., total number of military items) are different.

G.4 OUTPUT DATA

Estimates of impact probability (P) and number of exposures (T) for a given species of interest, were made for the specified training or testing area with the highest annual number of military items used for each of the three alternatives. The calculations derived P and T from the highest annual number of military items used in the Study Area for the given alternative. Differences in P and T among the alternatives arise from different numbers of events (and therefore military items) for the three alternatives.

Results for marine mammals and sea turtles are presented in Tables G-1 and G-2.

Table G-1: Estimated Marine Mammal Exposures from Direct Strike of Munitions and Other Items by Alternative

Mariana Islands Training and Testing Study Area						
Species	**Training**			**Testing**		
	No Action	**Alternative 1**	**Alternative 2**	**No Action**	**Alternative 1**	**Alternative 2**
Humpback Whale	0.000012	0.000040	0.000038	<0.000001	0.000001	0.000001
Blue Whale	<0.000001	0.000001	0.000001	<0.000001	<0.000001	<0.000001
Fin Whale	<0.000001	0.000001	0.000001	<0.000001	<0.000001	<0.000001
Sei Whale	<0.000001	0.000013	0.000013	<0.000001	<0.000001	<0.000001
Sperm Whale	0.000034	0.000107	0.000110	0.000001	0.000003	0.000003
Pantropical Spotted Dolphin[1]	0.000049	0.000156	0.000161	<0.000001	0.000003	0.000003

[1] This is the non-ESA-listed marine mammal species with the highest average seasonal density in the training and testing area of interest.

Table G-2: Estimated Sea Turtle Exposures from Direct Strike of Military Expended Materials by Area and Alternative

Mariana Islands Training and Testing Study Area						
Nearshore Area (Study Area shallower than 200 meters [m])						
Species	**Training**			**Testing**		
	No Action	**Alternative 1**	**Alternative 2**	**No Action**	**Alternative 1**	**Alternative 2**
Green Sea Turtle	0.00092	0.00231	0.00231	0.00001	0.00005	0.00005
Hawksbill Sea Turtle	0.00005	0.00014	0.00014	<0.00001	<0.00001	<0.00001
Loggerhead Sea Turtle	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Olive Ridley Sea Turtle	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Leatherback Sea Turtle	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Open Ocean (Study Area deeper than 200 m)						
Species	**Training**			**Testing**		
	No Action	**Alternative 1**	**Alternative 2**	**No Action**	**Alternative 1**	**Alternative 2**
All Turtle Species	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001

This Page Intentionally Left Blank

Appendix H: Biological Resource Methods

TABLE OF CONTENTS

LIST OF TABLES

There are no tables in this section.

LIST OF FIGURES

This Page Intentionally Left Blank

APPENDIX H BIOLOGICAL RESOURCE METHODS

Appendix H outlines the conceptual framework for assessing effects on biological resources from sound-producing activities, energy-producing activities, physical disturbance or strike, entanglement, and ingestion.

H.1 CONCEPTUAL FRAMEWORK FOR ASSESSING EFFECTS FROM SOUND-PRODUCING ACTIVITIES

This conceptual framework describes the different types of effects that are possible and the potential relationships between sound stimuli and long-term consequences for the individual and population. The conceptual framework is central to the assessment of acoustic-related effects and is consulted multiple times throughout the process. It describes potential effects and the pathways by which an acoustic stimulus or sound-producing activity can potentially affect animals. The conceptual framework qualitatively describes costs to the animal (e.g., expended energy or missed feeding opportunity) that may be associated with specific reactions. Finally, the conceptual framework outlines the conditions that may lead to long-term consequences for the individual and population if the animal cannot fully recover from the short-term effects. Within each biological resource section (e.g., marine mammals, birds, and fish,) the detailed methods to predict effects to specific taxa are derived from this conceptual framework.

An animal is considered “exposed” to a sound if the received sound level at the animal’s location is above the background ambient noise level within a similar frequency band. A variety of effects may result from exposure to sound-producing activities. The severity of these effects can vary greatly between minor effects that have no real cost to the animal, to more severe effects that may have lasting consequences. Whether a marine animal is significantly affected must be determined from the best available scientific data regarding the potential physiological and behavioral responses to sound-producing activities and the possible costs and long-term consequences of those responses.

The major categories of potential effects are:

- Direct trauma
- Auditory fatigue
- Auditory masking
- Behavioral reactions
- Physiological stress

Direct trauma refers to injury to organs or tissues of an animal as a direct result of an intense sound wave or shock wave impinging upon or passing through its body. Potential impacts on an animal’s internal tissues and organs are assessed by considering the characteristics of the exposure and the response characteristics of the tissues. Trauma can be mild and fully recoverable, with no long-term repercussions to the individual or population, or more severe, with the potential for lasting effects or, in some cases, mortality.

Auditory fatigue may result from over-stimulation of the delicate hair cells and tissues within the auditory system. The most familiar effect of auditory fatigue is hearing loss, also called a noise-induced threshold shift, meaning an increase in the hearing threshold.

Audible natural and artificial sounds can potentially result in auditory masking, a condition that occurs when noise interferes with an animal's ability to hear other sounds and may affect the animal's ability to communicate, such as requiring the animal to adjust the frequency or loudness of its call. Masking occurs when the perception of a sound is interfered with by a second sound, and the probability of masking increases as the two sounds increase in similarity and the masking sound increases in level. It is important to distinguish auditory fatigue, which persists after the sound exposure, from masking, which occurs only during the sound exposure.

Marine animals naturally experience physiological stress as part of their normal life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with conspecifics (members of the same species), and interactions with predators all contribute to the stress a marine animal naturally experiences. The physiological response to a stressor, often termed the stress response, is an adaptive process that helps an animal cope with changing external and internal environmental conditions. However, too much of a stress response can be harmful to an animal, resulting in physiological dysfunction. In some cases, naturally occurring stressors can have profound impacts on animals. Sound-producing activities have the potential to provide additional stress, which must be considered, not only for its direct impact on an animal's behavior but also for contributing to an animal's chronic stress level.

A sound-producing activity can cause a variety of behavioral reactions in animals ranging from very minor and brief, to more severe reactions such as aggression or prolonged flight. The acoustic stimuli can cause a stress reaction (i.e., startle or annoyance); they may act as a cue to an animal that has experienced a stress reaction in the past to similar sounds or activities, or that acquired a learned behavioral response to the sounds from conspecifics. An animal may choose to deal with these stimuli or ignore them based on the severity of the stress response, the animal's past experience with the sound, as well as other stimuli present in the environment. If an animal chooses to react to the acoustic stimuli, then the behavioral responses fall into two categories: alteration of an ongoing behavior pattern or avoidance. The specific type and severity of these reactions helps determine the costs and ultimate consequences to the individual and population.

H.2 FLOWCHART

Figure H.2-1 is a flowchart that diagrams the process used to evaluate the potential effects on marine animals from sound-producing activities. The shape and color of each box on the flowchart represent either a decision point in the analysis (green diamonds); specific processes such as responses, costs, or recovery (blue rectangles); external factors to consider (purple parallelograms); and final outcomes for the individual or population (orange ovals and rectangles). Each box is labeled for reference throughout the appendix. For simplicity, sound is used to include not only acoustic waves but also shock waves generated from explosive sources. The supporting text in the appendix clarifies those instances where it is necessary to distinguish between the two phenomena.

Box A1, the Sound-Producing Activity, is the source of the sound stimuli and therefore the starting point in the analysis. Each of the five major categories of potential effects (i.e., direct trauma, auditory fatigue, masking, behavioral response, and stress) are presented as pathways that flow from left to right across the diagram. Pathways are not exclusive, and each must be followed until it can be concluded that an animal is not at risk for that specific effect. The vertical columns show the steps in the analysis used to examine each of the effects pathways. These steps proceed from the stimuli, to the physiological responses, to any potential behavioral responses, to the costs to the animal, to the recovery of the animal, and finally to the long-term consequences for the individual and population.

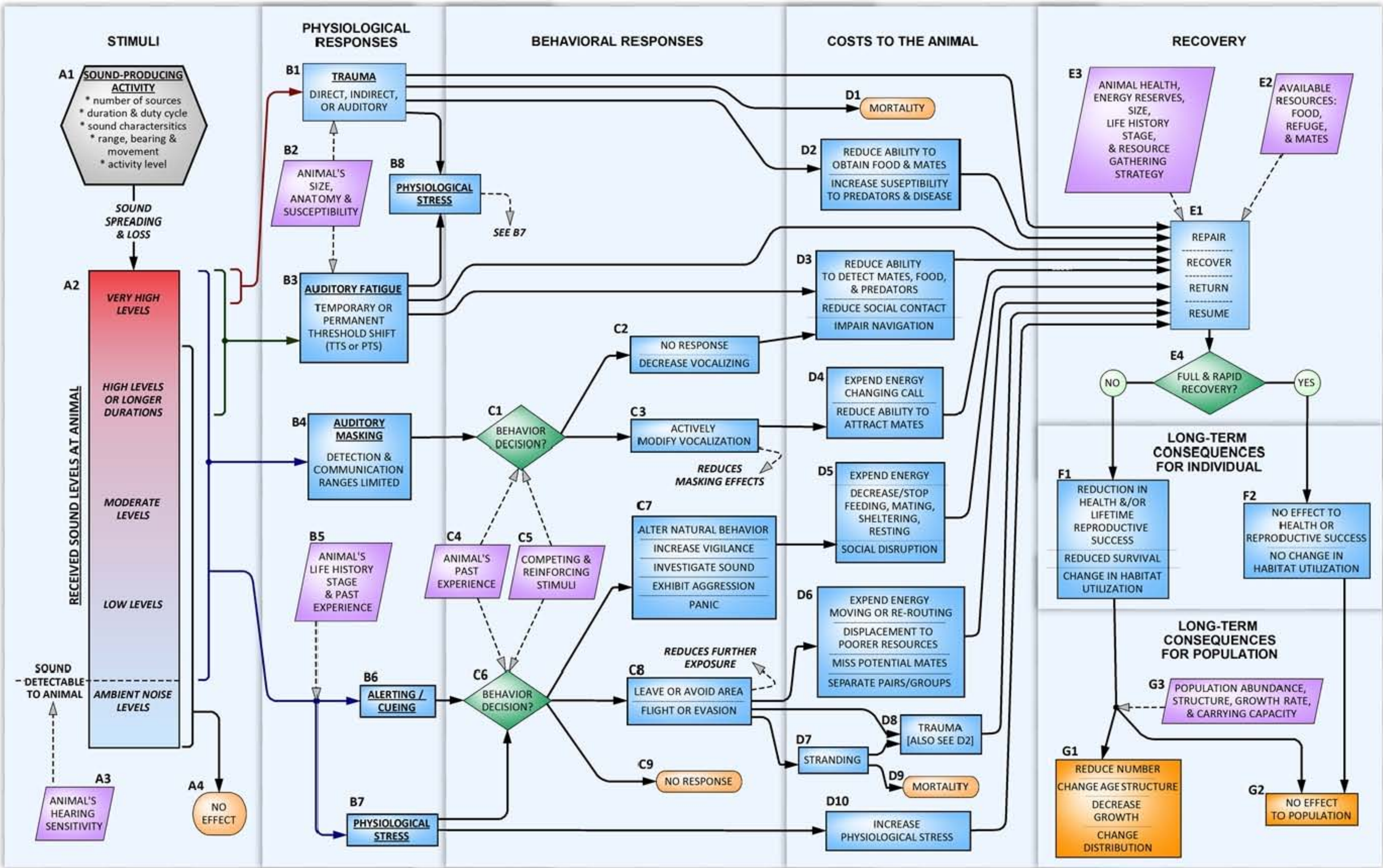


Figure H.2-1: Flow Chart of the Evaluation Process of Sound-Producing Activities

H.2.1 STIMULI

The first step in predicting whether a sound-producing activity is capable of causing an effect on a marine animal is to define the stimuli experienced by the animal. The stimuli include the sound-producing activity, the surrounding acoustical environment, and the characteristics of the sound when it reaches the animal, and whether the animal can detect the sound.

Sounds emitted from a sound-producing activity (Box A1) travel through the environment to create a spatially variable sound field. There can be any number of individual sound sources in a given activity, each with its own unique characteristics. For example, a Navy training exercise may involve several ships and aircraft, several types of sonar, and several types of ordnance. Each of the individual sound sources has unique characteristics: source level, frequency, duty cycle, duration, and rise-time (i.e., impulsive vs. non-impulsive). Each source also has a range, depth/altitude, bearing and directionality, and movement relative to the animal.

Environmental factors such as temperature, salinity, bathymetry, bottom type, and sea state all impact how sound spreads through the environment and how sound decreases in amplitude between the source and the receiver (individual animal). Mathematical calculations and computer models are used to predict how the characteristics of the sound will change between the source and the animal under a range of realistic environmental conditions for the locations where sound-producing activities occur.

The details of the overall activity may also be important to place the potential effects into context and help predict the range of severity of the probable reactions. The overall activity level (e.g., number of ships and aircraft involved in exercise); the number of sound sources within the activity; the activity duration; and the range, bearing, and movement of the activity relative to the animal are all considered.

The received sound at the animal and the number of times the sound is experienced (i.e., repetitive exposures) (Box A2) determines the range of possible effects. Sounds that are higher than the ambient noise level and within an animal's hearing sensitivity range (Box A3) have the potential to cause effects. Very high exposure levels may have the potential to cause trauma; high-level exposures, long-duration exposures, or repetitive exposures may potentially cause auditory fatigue; lower-level exposures may potentially lead to masking; all perceived levels may lead to stress; and many sounds, including sounds that are not detectable by the animal, would have no effect (Box A4).

H.2.2 PHYSIOLOGICAL RESPONSES

Physiological Responses include direct trauma, hearing loss, auditory masking, and stress. The magnitude of the involuntary response is predicted based on the characteristics of the acoustic stimuli and the characteristics of the animal (species, susceptibility, life history stage, size, and past experiences).

Trauma

Physiological responses to sound stimulation may range from mechanical vibration (with no resulting adverse effects) to tissue trauma (injury). Direct trauma (Box B1) refers to the direct injury of tissues and organs by sound waves impinging upon or traveling through an animal's body. Marine animals' bodies, especially their auditory systems, are well adapted to large hydrostatic pressures and large, but relatively slow, pressure changes that occur with changing depth. However, mechanical trauma may result from exposure to very-high-amplitude sounds when the elastic limits of the auditory system are exceeded or when animals are exposed to intense sounds with very rapid rise times, such that the tissues cannot respond adequately to the rapid pressure changes. Trauma to marine animals from sound exposure requires high received levels. Trauma effects therefore normally only occur with very-high-amplitude, often impulsive, sources, and at relatively close range, which limits the number of animals likely exposed to trauma-inducing sound levels.

Direct trauma includes both auditory and non-auditory trauma. Auditory trauma is the direct mechanical injury to hearing-related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the organ of Corti and the associated hair cells. Auditory trauma differs from auditory fatigue in that the latter involves the overstimulation of the auditory system at levels below those capable of causing direct mechanical damage. Auditory trauma is always injurious but can be temporary. One of the most common consequences of auditory trauma is hearing loss (see below).

Non-auditory trauma can include hemorrhaging of small blood vessels and the rupture of gas-containing tissues such as the lung, swim bladder, or gastrointestinal tract. After the ear (or other sound-sensing organs), these are usually the most sensitive organs and tissues to acoustic trauma. An animal's size and anatomy are important in determining its susceptibility to trauma (Box B2), especially non-auditory trauma. Larger size indicates more tissue to protect vital organs that might be otherwise susceptible (i.e., there is more attenuation of the received sound before it impacts non-auditory structures). Therefore, larger animals should be less susceptible to trauma than smaller animals. In some cases, acoustic resonance of a structure may enhance the vibrations resulting from noise exposure and result in an increased susceptibility to trauma. Resonance is a phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration, or the particular frequency at which the object vibrates most readily. The size, geometry, and material composition of a structure determine the frequency at which the object will resonate. The potential for resonance is determined by comparing the sound frequencies with the resonant frequency and damping of the tissues. Because most biological tissues are heavily damped, the increase in susceptibility from resonance is limited.

Vascular and tissue bubble formation resulting from sound exposure is a hypothesized mechanism of indirect trauma to marine animals. The risk of bubble formation from one of these processes, called rectified diffusion, is based on the amplitude, frequency, and duration of the sound (Crum and Mao 1996) and an animal's tissue nitrogen gas saturation at the time of the exposure. Rectified diffusion is the growth of a bubble that fluctuates in size because of the changing pressure field caused by the sound wave. An alternative, but related, hypothesis has also been suggested: stable microbubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of gas-supersaturated tissues. Bubbles have also been hypothesized to result from changes in the dive behavior of marine mammals as a result of sound exposure (Jepson et al. 2003). Vascular bubbles produced by this mechanism would not be a physiological response to the sound exposure, but a cost to the animal because of the change in behavior (Section H.2.4, Costs to the Animal). Under either of these hypotheses, several things could happen: (1) bubbles could grow to the extent that vascular blockage (emboli) and tissue hemorrhage occur, (2) bubbles could develop to the extent that a complement immune response is triggered or the nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs, or (3) the bubbles could be cleared by the lung without negative consequence to the animal. Although rectified diffusion is a known phenomenon, its applicability to diving marine animals exposed to sound is questionable; animals would need to be highly supersaturated with gas and very close to a high-level sound source (Crum et al. 2005). The other two hypothesized phenomena are largely theoretical and have not been demonstrated under realistic exposure conditions.

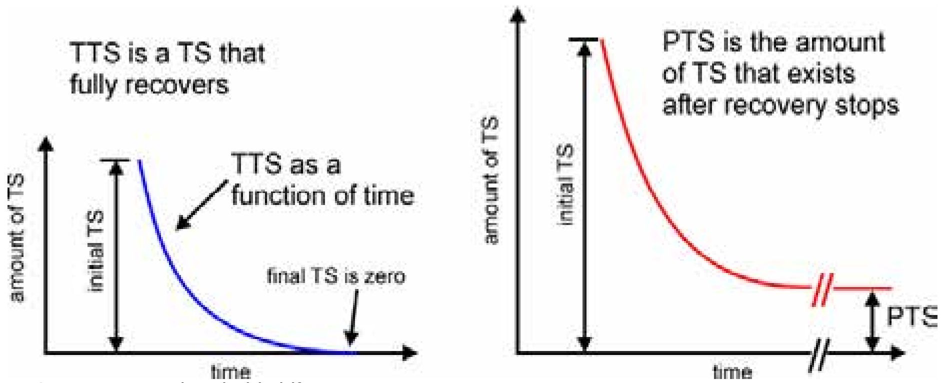
Auditory Fatigue

Auditory fatigue is a reduction in hearing ability resulting from overstimulation to sounds. The mechanisms responsible for auditory fatigue differ from auditory trauma and may consist of a variety of mechanical and biochemical processes, including physical damage or distortion of the tympanic membrane (not including tympanic membrane rupture) and cochlear hair cell stereocilia, oxidative stress-related hair cell death, changes in cochlear blood flow, and swelling of cochlear nerve terminals resulting from glutamate excitotoxicity (Henderson et al. 2006; Kujawa and Liberman 2009). Although the outer hair cells are the most prominent target for fatigue effects, severe noise exposures may also result in inner hair cell death and loss of auditory nerve fibers (Henderson et al. 2006). Auditory fatigue is possibly the best studied type of effect from sound exposures in marine and terrestrial animals, including humans. The characteristics of the received sound stimuli are used and compared to the animal's hearing sensitivity and susceptibility to noise (Box A3) to determine the potential for auditory fatigue.

Auditory fatigue manifests itself as hearing sensitivity loss, called a noise-induced threshold shift. A threshold shift may be either permanent threshold shift (PTS), or temporary threshold shift (TTS). Note that the term "auditory fatigue" is often used to mean a TTS; however, in this analysis, a more general meaning to differentiate fatigue mechanisms (e.g., metabolic exhaustion and distortion of tissues) from auditory trauma mechanisms (e.g., physical destruction of cochlear tissues occurring at the time of exposure) is used.

The distinction between PTS and TTS is based on whether there is a complete recovery of hearing sensitivity following a sound exposure. If the threshold shift eventually returns to zero (the animal's hearing returns to pre-exposure value), the threshold shift is a TTS. 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. Figure H.2-2 shows one hypothetical threshold shift that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

The relationship between TTS and PTS is complicated and poorly understood, even in humans and terrestrial mammals, where numerous studies failed to delineate a clear relationship between the two. Relatively small amounts of TTS (e.g., less than 40–50 decibels [dB] measured 2 minutes after exposure) will recover with no apparent long-term effects; however, terrestrial mammal studies revealed that large amounts of TTS (e.g., approximately 40 dB measured 24 hours after exposure) can result in permanent neural degeneration, despite the hearing thresholds returning to normal (Kujawa and Liberman 2009). The amounts of TTS induced by Kujawa and Liberman (2009) were described as being "at the limits of reversibility." It is unknown whether smaller amounts of TTS can result in similar neural degeneration, or if effects would translate to other species such as marine animals.



TTS = temporary threshold shift
TS = threshold shift
PTS = permanent threshold shift

Figure H.2-2: Two Hypothetical Threshold Shifts

The amplitude, frequency, duration, and temporal pattern of the sound exposure are important parameters for predicting the potential for auditory fatigue. Duration is particularly important because auditory fatigue is exacerbated with prolonged exposure time. The frequency of the sound also plays an important role in susceptibility to hearing loss. Experiments show that animals are most susceptible to fatigue (Box B3) within their most sensitive hearing range. Sounds outside of an animal's audible frequency range do not cause fatigue.

The greater the degree of threshold shift, the smaller the ocean space within which an animal can detect biologically relevant sounds and communicate. This is referred to as reducing an animal's "acoustic space." This reduction can be estimated given the amount of threshold shift incurred by an animal.

Auditory and Communication Masking

Auditory masking occurs if the noise from an activity interferes with an animal's ability to detect, understand, elicit, or recognize biologically relevant sounds of interest (Box B4). "Noise" refers to unwanted or unimportant sounds that mask an animal's ability to hear "sounds of interest" and affect an animal's ability to generate sounds (or call). A sound of interest refers to a sound that is potentially being detected. Sounds of interest include echolocation clicks; sounds from predators; natural, abiotic sounds that may aid in navigation; and reverberation, which can give an animal information about its location and orientation within the ocean. Sounds of interest are frequently generated by conspecifics such as offspring, mates, and competitors.

The frequency, received level, and duty cycle of the noise determine the potential degree of auditory masking. Similar to hearing loss, the greater the degree of masking, the smaller the ocean space within which an animal can detect biologically relevant sounds.

Physiological Stress

If a sound is detected (i.e., heard or sensed) by an animal, a stress response can occur (Box B7); or the sound can cue or alert the animal (Box B6) without a direct, measurable stress response. If an animal suffers trauma or auditory fatigue, a physiological stress response will occur (Box B8). A stress response is a physiological change resulting from a stressor that is meant to help the animal deal with the stressor. The generalized stress response is characterized by a release of hormones (Reeder and Kramer 2005); however, it is now acknowledged that other chemicals produced in a stress response (e.g., stress markers) exist. For example, a release of reactive oxidative compounds, as occurs in noise-induced hearing loss (Henderson et al. 2006), occurs in response to some acoustic stressors. Stress hormones include those produced by the sympathetic nervous system, norepinephrine and epinephrine (i.e., the catecholamines), which produce elevations in the heart and respiration rate, increase awareness, and increase the availability of glucose and lipid for energy. Other stress hormones are the glucocorticoid steroid hormones cortisol and aldosterone, which are produced by the adrenal gland. These hormones are classically used as an indicator of a stress response and to characterize the magnitude of the stress response (Hennessy et al. 1979). Oxidative stress occurs when reactive molecules, called reactive oxygen species, are produced in excess of molecules that counteract their activity (i.e., antioxidants).

An acute stress response is traditionally considered part of the startle response and is hormonally characterized by the release of the catecholamines. Annoyance type reactions may be characterized by the release of either or both catecholamines and glucocorticoid hormones. Regardless of the physiological changes that make up the stress response, the stress response may contribute to an animal’s decision to alter its behavior. Alternatively, a stimulus may not cause a measurable stress response but may act as an alert or cue to an animal to change its behavior. This response may occur because of learned associations; the animal may have experienced a stress reaction in the past to similar sounds or activities (Box C4), or it may have learned the response from conspecifics. The severity of the stress response depends on the received sound level at the animal (Box A2); the details of the sound-producing activity (Box A1); the animal’s life history stage (e.g., juvenile or adult; breeding or feeding season) (Box B5); and the animal’s past experience with the stimuli (Box B5). These factors would be subject to individual variation, as well as variation within an individual over time.

An animal’s life history stage is an important factor to consider when predicting whether a stress response is likely (Box B5). An animal’s life history stage includes its level of physical maturity (i.e., larva, infant, juvenile, sexually mature adult) and the primary activity in which it is engaged such as mating, feeding, or rearing/caring for young. Animals engaged in a critical life activity such as mating or feeding may have a lesser stress response than an animal engaged in a more flexible activity such as resting or migrating (i.e., an activity that does not necessarily depend on the availability of resources). The animal’s past experiences with the stimuli or similar stimuli are another important consideration. Prior experience with a stressor may be of particular importance because repeated experience with a stressor may dull the stress response via acclimation (St. Aubin and Dierauf 2001) or increase the response via sensitization.

H.2.3 Behavioral Responses

Any number of Behavioral Responses can result from a physiological response. An animal responds to the stimulus based on a number of factors in addition to the severity of the physiological response. An animal’s experience with the sound (or similar sounds), the context of the acoustic exposure, and the presence of other stimuli contribute to determining its reaction from a suite of possible behaviors.

Behavioral responses fall into two major categories: alterations in natural behavior patterns, and avoidance. These types of reactions are not mutually exclusive, and many overall reactions may be combinations of behaviors or a sequence of behaviors. Severity of behavioral reactions can vary drastically between minor and brief reorientations of the animal to investigate the sound, to severe reactions such as aggression or prolonged flight. The type and severity of the behavioral response will determine the cost to the animal.

Trauma and Auditory Fatigue

Direct trauma and auditory fatigue increases the animal’s physiological stress (Box B8), which feeds into the stress response (Box B7). Direct trauma and auditory fatigue increase the likelihood or severity of a behavioral response and increase an animal's overall physiological stress level (Box D10).

Auditory Masking

A behavior decision is made by the animal when the animal detects increased background noise, or possibly when the animal recognizes that biologically relevant sounds are being masked (Box C1). An animal’s past experience with the sound-producing activity or similar acoustic stimuli can affect its choice of behavior during auditory masking (Box C4). Competing and reinforcing stimuli may also affect its decision (Box C5).

An animal may exhibit a passive behavioral response when coping with auditory masking (Box C2). It may simply not respond and keep conducting its current natural behavior. An animal may also stop calling until the background noise decreases. These passive responses do not present a direct energetic cost to the animal; however, auditory masking will continue, depending on the acoustic stimuli.

An animal may to actively compensate for auditory masking (Box C3). An animal can vocalize more loudly to make its signal heard over the masking noise. An animal may also shift the frequency of its vocalizations away from the frequency of the masking noise. This shift can actually reduce the masking effect for the animal and other animals that are “listening” in the area. For example, in marine mammals, vocalization changes have been reported from exposure to human-generated noise sources such as sonar, vessel noise, and seismic surveying. Changes included mimicry of the sound, cessation of vocalization, increases and decreases in vocalization length, increases and decreases in vocalization rate, and increases in vocalization frequency and level, while other animals showed no significant changes in the presence of human-generated sound.

An animal’s past experiences can be important in determining what behavior decision it may make when dealing with auditory masking (Box C4). Past experience can be with the sound-producing activity itself or with similar acoustic stimuli. For example, an animal may modify its vocalizations to reduce the effects of masking noise.

Other stimuli present in the environment can influence an animal’s behavior decision (Box C5). These stimuli can be other acoustic stimuli not directly related to the sound-producing activity; they can be visual, olfactory, or tactile stimuli; the stimuli can be conspecifics or predators in the area; or the stimuli can be the strong drive to engage in a natural behavior. In some cases, natural motivations may suppress any behavioral reactions elicited by the acoustic stimulus. For example, an animal involved in mating or foraging may not react with the same degree of severity as it may have otherwise. Reinforcing stimuli reinforce the behavioral reaction caused by acoustic stimuli. For example, awareness of a predator in the area coupled with the acoustic stimuli may elicit a stronger reaction than the acoustic stimuli itself otherwise would have. The visual stimulus of seeing ships and aircraft, coupled with the acoustic stimuli, may also increase the likelihood or severity of a behavioral response.

Behavioral Reactions and Physiological Stress

A physiological stress response (Box B7) such as an annoyance or startle reaction, or a cueing or alerting reaction (Box B6) may cause an animal to make a behavior decision (Box C6). Any exposure that produces an injury or auditory fatigue is also assumed to produce a stress response (Box B7) and increase the severity or likelihood of a behavioral reaction. Both an animal's past experience (Box C4) and competing and reinforcing stimuli (Box C5) can affect an animal's behavior decision. The decision can result in three general types of behavioral reactions: no response (Box C9), area avoidance (Box C8), or alteration of a natural behavior (Box C7).

Little data exist that correlate specific behavioral reactions with specific stress responses. Therefore, in practice, the likely range of behavioral reactions is estimated from the acoustic stimuli instead of the magnitude of the stress response. It is assumed that a stress response must exist to alter a natural behavior or cause an avoidance reaction. Estimates of the types of behavioral responses that could occur for a given sound exposure can be determined from the literature.

An animal's past experiences can be important in determining what behavior decision it may make when dealing with a stress response (Box C4). Past experience can be with the sound-producing activity itself or with similar sound stimuli. Bejder et al. (2009) define habituation as, "a process involving a reduction in response over time as individuals learn that there are neither adverse nor beneficial consequences of the occurrence of the stimulus." An animal habituated to a particular stimulus may have a lesser (or no) behavioral response to the stimulus compared to the first time the animal encountered the stimulus. Sensitization is the opposite of habituation, and refers to an increase over time in an animal's behavioral response to a repeated or continuous stimulus (Bejder et al. 2009). An animal sensitized to a particular stimulus exhibits an increasingly intense response to the stimulus (e.g., fleeing faster or farther), because there are significant consequences for the animal. A related behavioral response, tolerance, refers to an animal's ability to endure, or tolerate, a disturbance without a defined response. Habituation and sensitization are measured by the tolerance levels exhibited by animals; habituated animals show a progressively increasing tolerance to stimuli whereas sensitized animals show a progressively decreasing tolerance to stimuli (Bejder et al. 2009).

Other stimuli (Box C5) present in the environment can influence an animal's behavior decision (Box C6). These stimuli may not be directly related to the sound-producing activity, such as visual stimuli; the stimuli can be conspecifics or predators in the area, or the stimuli can be the strong drive to engage or continue in a natural behavior. In some cases, natural motivations (e.g., competing stimuli) may suppress any behavioral reactions elicited by the acoustic stimulus. For example, an animal involved in mating or foraging may not react with the same degree of severity as an animal involved in less-critical behavior. Reinforcing stimuli reinforce the behavioral reaction caused by acoustic stimuli. For example, the awareness of a predator in the area coupled with the acoustic stimuli may elicit a stronger reaction than the acoustic stimuli themselves otherwise would have.

The visual stimulus of seeing human activities such as ships and aircraft maneuvering, coupled with the acoustic stimuli, may also increase the likelihood or severity of a behavioral response. It is difficult to separate the stimulus of the sound from the visual stimulus of the ship or platform creating the sound. The sound may act as a cue, or as one stimulus of many that the animal is considering when deciding how to react. An activity with several platforms (e.g., ships and aircraft) may elicit a different reaction than an activity with a single platform, both with similar acoustic footprints. The total number of vehicles and platforms involved, the size of the activity area, and the distance between the animal and activity are important considerations when predicting behavioral responses.

An animal may reorient or become more vigilant if it detects a sound-producing activity (Box C7). Some animals may investigate the sound using other sensory systems (e.g., vision), and perhaps move closer to the sound source. Reorientation, vigilance, and investigation all require the animal to divert attention and resources and therefore slow or stop their presumably beneficial natural behavior. This can be a very brief diversion, after which the animal continues its natural behavior, or an animal may not resume its natural behaviors until after a longer period when the animal has habituated to or learned to tolerate the sound or the activity has concluded. An intentional change via an orienting response represents behaviors that would be considered mild disruption. More severe alterations of natural behavior would include aggression or panic.

An animal may choose to leave or avoid an area where a sound-producing activity is taking place (Box C8). Avoidance is the displacement of an individual from an area. A more severe form of this comes in the form of flight or evasion. A flight response is a dramatic change in normal movement to a directed and rapid movement away from the detected location of a sound source. Avoidance of an area can help the animal avoid further acoustic effects by avoiding or reducing further exposure.

An animal may choose not to respond to a sound-producing activity (Box C9). The physiological stress response may not rise to the level that would cause the animal to modify its behavior. The animal may have habituated to the sound or simply learned through past experience that the sound is not a threat. In this case a behavioral effect would not be predicted. An animal may choose not to respond to a sound-producing activity in spite of a physiological stress response. Some combination of competing stimuli may be present such as a robust food patch or a mating opportunity that overcomes the stress response and suppresses any potential behavioral responses. If the noise-producing activity persists over long periods or reoccurs frequently, the stress felt by animals could increase their chronic stress levels.

H.2.4 Costs to the Animal

The potential costs to a marine animal from an involuntary or behavioral response include no measurable cost, expended energy reserves, increased stress, reduced social contact, missed opportunities to secure resources or mates, displacement, and stranding or severe evasive behavior (which may potentially lead to secondary trauma or death). Animals suffer costs on a daily basis from a host of natural situations such as dealing with predator or competitor pressure. If the costs to the animal from an acoustic-related effect fall outside of its normal daily variations, then individuals must recover from significant costs to avoid long-term consequences.

Trauma

Trauma or injury to an animal may reduce its ability to secure food by reducing its mobility or the efficiency of its sensory systems, make the injured individual less attractive to potential mates, or increase an individual’s chances of contracting diseases or falling prey to a predator (Box D2). A severe trauma can lead to the death of the individual (Box D1).

Auditory Fatigue and Auditory Masking

Auditory fatigue and masking can impair an animal’s ability to hear biologically important sounds (Box D3), especially fainter and distant sounds. Sounds could belong to conspecifics such as other individuals in a social group (e.g., pod, school, etc.), potential mates, potential competitors, or parents/offspring. Biologically important sounds could also be an animal’s own biosonar echoes used to detect prey, sounds from predators, and sounds from the physical environment. Therefore, auditory masking or a hearing loss could reduce an animal's ability to contact social groups, offspring, or parents; and reduce opportunities to detect or attract more distant mates. Animals may also use sounds to gain information about their physical environment by detecting the reverberation of sounds in the underwater space or sensing the sound of crashing waves on a nearby shoreline. These cues could be used by some animals to migrate long distances or navigate their immediate environment. Therefore, an animal's ability to navigate may be impaired if the animal uses acoustic cues from the physical environment to help identify its location. Auditory masking and fatigue both effectively reduce the animal's acoustic space and the ocean volume in which detection and communication are effective.

An animal that modifies its vocalization in response to auditory masking could incur a cost (Box D4). Modifying vocalizations may cost the animal energy from its finite energy budget, interfere with the behavioral function of a call, or reduce a signaler's apparent quality as a mating partner. For example, songbirds that shift their calls up an octave to compensate for increased background noise attract fewer or less-desirable mates, and many terrestrial species advertise body size and quality with low-frequency vocalizations (Slabbekoorn and Ripmeester 2008). Increasing the frequency of these vocalizations could reduce a signaler's attractiveness in the eyes of potential mates even as it improves the overall detectability of the call.

Auditory masking or auditory fatigue may also lead to no measurable costs for an animal. Masking could be of short duration or intermittent so that continuous or repeated biologically important sounds are received by the animal between masking noise. Auditory fatigue could also be inconsequential for an animal if the frequency range affected is not critical for that animal to hear within, or the auditory fatigue is of such short duration (a few minutes) that there are no costs to the individual.

Behavioral Reactions and Physiological Stress

An animal that alters its natural behavior in response to stress or an auditory cue may slow or cease its presumably beneficial natural behavior and instead expend energy reacting to the sound-producing activity (Box D5). Beneficial natural behaviors include feeding, breeding, sheltering, and migrating. The cost of feeding disruptions depends on the energetic requirements of individuals and the potential amount of food missed during the disruption. Alteration in breeding behavior can result in delaying reproduction. The costs of a brief interruption to migrating or sheltering are less clear. Most behavior alterations also require the animal to expend energy for a nonbeneficial behavior. The amount of energy expended depends on the severity of the behavioral response.

An animal that avoids a sound-producing activity may expend additional energy moving around the area, be displaced to poorer resources, miss potential mates, or have social interactions affected (Box D6). Avoidance reactions can cause an animal to expend energy. The amount of energy expended depends on the severity of the behavioral response. Missing potential mates can result in delaying reproduction. Social groups or pairs of animals, such as mates or parent/offspring pairs, could be separated during a severe behavioral response such as flight. Offspring that depend on their parents may die if they are permanently separated. Splitting up an animal group can result in a reduced group size, which can have secondary effects on individual foraging success and susceptibility to predators.

Some severe behavioral reactions can lead to stranding (Box D7) or secondary trauma (Box D8). Animals that take prolonged flight, a severe avoidance reaction, may injure themselves or strand in an environment for which they are not adapted. Some trauma is likely to occur to an animal that strands (Box D8). Trauma can reduce the animal's ability to secure food and mates, and increase the animal's susceptibility to predation and disease (Box D2). An animal that strands and does not return to a hospitable environment quickly will likely die (Box D9).

Elevated stress levels may occur whether or not an animal exhibits a behavioral response (Box D10). Even while undergoing a stress response, competing stimuli (e.g., food or mating opportunities) may overcome an animal's initial stress response during the behavior decision. Regardless of whether the animal displays a behavioral reaction, this tolerated stress could incur a cost to the animal. Reactive oxygen species produced during normal physiological processes are generally counterbalanced by enzymes and antioxidants; however, excess stress can result in an excess production of reactive oxygen species, leading to damage of lipids, proteins, and nucleic acids at the cellular level (Sies 1997; Touyz 2004).

H.2.5 Recovery

The predicted recovery of the animal (Box E1) is based on the cost of any masking or behavioral response and the severity of any involuntary physiological reactions (e.g., direct trauma, hearing loss, or increased chronic stress). Many effects are fully recoverable upon cessation of the sound-producing activity, and the vast majority of effects are completely recoverable over time; whereas a few effects may not be fully recoverable. The availability of resources and the characteristics of the animal play a critical role in determining the speed and completeness of recovery.

Available resources fluctuate by season, location, and year and can play a major role in an animal's rate of recovery (Box E2). Plentiful food can aid in a quicker recovery, whereas recovery can take much longer if food resources are limited. If many potential mates are available, an animal may recover quickly from missing a single mating opportunity. Refuge or shelter is also an important resource that may give an animal an opportunity to recover or repair after an incurred cost or physiological response.

An animal's health, energy reserves, size, life history stage, and resource gathering strategy affect its speed and completeness of recovery (Box E3). Animals that are in good health and have abundant energy reserves before an effect will likely recover more quickly. Adult animals with stored energy reserves (e.g., fat reserves) may have an easier time recovering than juveniles that expend their energy growing and developing and have less in reserve. Large individuals and large species may recover more quickly, also due to having more potential for energy reserves. Animals that gather and store resources, perhaps fasting for months during breeding or offspring rearing seasons, may have a more difficult time recovering from being temporarily displaced from a feeding area than an animal that feeds year round.

Damaged tissues from mild to moderate trauma may heal over time. The predicted recovery of direct trauma is based on the severity of the trauma, availability of resources, and characteristics of the animal. After a sustained injury an animal's body attempts to repair tissues. The animal may also need to recover from any potential costs due to a decrease in resource gathering efficiency and any secondary effects from predators or disease (Box E1). Moderate to severe trauma that does not cause mortality may never fully heal.

Small to moderate amounts of hearing loss may recover over a period of minutes to days, depending on the nature of the exposure and the amount of initial threshold shift. Severe noise-induced hearing loss may not fully recover, resulting in some amount of permanent hearing loss.

Auditory masking only occurs when the sound source is operating; therefore, direct masking effects stop immediately upon cessation of the sound-producing activity (Box E1). Natural behaviors may resume shortly after or even during the acoustic stimulus after an initial assessment period by the animal. Any energetic expenditures and missed opportunities to find and secure resources incurred from masking or a behavior alteration may take some time to recover.

Animals displaced from their normal habitat due to an avoidance reaction may return over time and resume their natural behaviors, depending on the severity of the reaction and how often the activity is repeated in the area. In areas of repeated and frequent acoustic disturbance, some animals may habituate to or learn to tolerate the new baseline or fluctuations in noise level. More sensitive species, or animals that may have been sensitized to the stimulus over time due to past negative experiences, may not return to an area. Other animals may return but not resume use of the habitat in the same manner as before the acoustic-related effect. For example, an animal may return to an area to feed or navigate through it to get to another area, but that animal may no longer seek that area as refuge or shelter.

Frequent milder physiological responses to an individual may accumulate over time if the time between sound-producing activities is not adequate to give the animal an opportunity to fully recover. An increase in an animal's chronic stress level is also possible if stress caused by a sound-producing activity does not return to baseline between exposures. Each component of the stress response is variable in time, and stress hormones return to baseline levels at different rates. For example, adrenaline is released almost immediately and is used or cleared by the system quickly, whereas glucocorticoid and cortisol levels may take long periods (i.e., hours to days) to return to baseline.

H.2.6 LONG-TERM CONSEQUENCES TO THE INDIVIDUAL AND THE POPULATION

The magnitude and type of effect and the speed and completeness of recovery must be considered in predicting long-term consequences to the individual animal and its population (Box E). Animals that recover quickly and completely from explosive or acoustic-related effects will likely not suffer reductions in their health or reproductive success, or experience changes in habitat utilization (Box F2). No population-level effects would be expected if individual animals do not suffer reductions in their lifetime reproductive success or change their habitat utilization (Box G2).

Animals that do not recover quickly and fully could suffer reductions in their health and lifetime reproductive success; they could be permanently displaced or change how they utilize the environment; or they could die (Box F1).

Severe injuries can lead to reduced survivorship (longevity), elevated stress levels, and prolonged alterations in behavior that can reduce an animal’s lifetime reproductive success. An animal with decreased energy stores or a lingering injury may be less successful at mating for one or more breeding seasons, thereby decreasing the number of offspring produced over its lifetime.

An animal whose hearing does not recover quickly and fully could suffer a reduction in lifetime reproductive success, because it may no longer be able to detect the calls of a mate as well as it could prior to losing hearing sensitivity (Box F1). This example underscores the importance of the frequency of sound associated with the hearing loss and how the animal relies on those frequencies (e.g., for mating, navigating, detecting predators). An animal with decreased energy stores or a PTS may be less successful at mating for one or more breeding seasons, thereby decreasing the number of offspring it can produce over its lifetime.

As mentioned above, the indirect effects of involuntary reaction of masking ends when the acoustic stimuli conclude. The direct effects of auditory masking could have long-term consequences for individuals if the activity was continuous or occurred frequently enough; however, most of the proposed training and testing activities are normally spread over vast areas and occur infrequently in a specific area.

Missed mating opportunities can have a direct effect on reproductive success. Reducing an animal's energy reserves over longer periods can directly reduce its health and reproductive success. Some species may not enter a breeding cycle without adequate energy stores, and animals that do breed may have a decreased probability of offspring survival. Animals displaced from their preferred habitat, or those who utilize it differently, may no longer have access to the best resources. Some animals that leave or flee an area during a noise-producing activity, especially an activity that is persistent or frequent, may not return quickly or at all. This can further reduce an individual's health and lifetime reproductive success.

Frequent disruptions to natural behavior patterns may not allow an animal to fully recover between exposures, which increase the probability of causing long-term consequences to individuals. Elevated chronic stress levels are usually a result of a prolonged or repeated disturbance. Excess stress produces reactive molecules in an animal's body that can result in cellular damage (Sies 1997; Touyz 2004). Chronic elevations in the stress levels (e.g., cortisol levels) may produce long-term health consequences that can reduce lifetime reproductive success.

These long-term consequences to the individual can lead to consequences for the population (Box G1). Population dynamics and abundance play a role in determining how many individuals would need to suffer long-term consequences before there was an effect on the population (Box G1). Long-term abandonment or a change in the utilization of an area by enough individuals can change the distribution of the population. Death has an immediate effect in that no further contribution to the population is possible, which reduces the animal's lifetime reproductive success.

Carrying capacity describes the theoretical maximum number of animals of a particular species that the environment can support. When a population nears its carrying capacity, the lifetime reproductive success in individuals may decrease due to finite resources or predator-prey interactions. Population growth is naturally limited by available resources and predator pressure. If one, or a few animals, in a population are removed or gather fewer resources, then other animals in the population can take advantage of the freed resources and potentially increase their health and lifetime reproductive success. Abundant populations that are near their carrying capacity (theoretical maximum abundance) that suffer effects to a few individuals may not be affected overall.

Populations that exist well below their carrying capacity (e.g., threatened or endangered species populations) may suffer greater consequences from any lasting effects to even a few individuals. Population-level consequences can include a change in the population dynamics, a decrease in the growth rate, or a change in geographic distribution. Changing the dynamics of a population (the proportion of the population within each age group) or their geographic distribution can also have secondary effects on population growth rates.

H.3 Conceptual Framework for Assessing Effects from Energy-Producing Activities

H.3.1 Stimuli

Magnitude of the Energy Stressor

Regulations do not provide threshold criteria to determine the significance of the potential effects from activities that involve the use of varying electromagnetic frequencies or lasers. Many organisms, primarily marine vertebrates, have been studied to determine their thresholds for detecting electromagnetic fields, as reviewed by Normandeau et al. (2011); however, there are no data on predictable responses to exposure above or below detection thresholds. The types of electromagnetic fields discussed are those from mine neutralization activities (magnetic influence minesweeping). The only types of lasers considered for analysis were low to moderate lasers (e.g., targeting systems, detection systems, laser light detection and ranging) that do not pose a risk to organisms (Swope 2010), and therefore will not be discussed further.

Location of the Energy Stressor

Evaluation of potential energy exposure risks considered the spatial overlap of the resource occurrence and electromagnetic field and high energy laser use. Wherever appropriate, specific geographic areas of potential impact were identified. The greatest potential electromagnetic energy exposure is at the source, where intensity is greatest. The strength of the electromagnetic field decreases by the inverse square law (e.g., if the distance from sensor to source increases by a factor of three, the field strength is reduced by a factor of nine [$3^2 = 9$]). The greatest potential for high energy laser exposure is at the ocean's surface, where high energy laser intensity is greatest. As the laser penetrates the water, 96 percent of the beam is absorbed, scattered, or otherwise lost (Zorn 2000; Ulrich 2004).

Behavior of the Organism

Evaluation of potential energy exposure risk considered the behavior of the organism, especially where the organism lives and feeds (e.g., surface, water column, seafloor). The analysis for electromagnetic devices considered those species with the ability to perceive or detect electromagnetic signals. The analysis for high energy lasers particularly considered those species known to inhabit the surface of the ocean.

H.3.2 Immediate Response and Costs to the Individual

Many different types of organisms (e.g., some invertebrates, fishes, turtles, birds, mammals) are sensitive to electromagnetic fields (Normandeau et al. 2011). An organism that encounters a disturbance in an electromagnetic field could respond by moving toward the source, moving away from it, or not responding at all. The types of electromagnetic devices used in the Proposed Action simulate the electromagnetic signature of a vessel passing through the water column, so the expected response would be similar to that of vessel movement. However, since there would be no actual strike potential, a physiological response would be unlikely in most cases. Recovery of an individual from encountering electromagnetic fields would be variable, but since the physiological response would likely be minimal, as reviewed by Normandeau et al. (2011), any recovery time would also be minimal.

Very little data or information are available to analyze potential impacts on organisms from exposure to high energy lasers. As with humans, the greatest laser-related concern for marine species is damage to an organism's ability to see. High energy lasers may also burn the skin, but the threshold energy level for eye damage is considerably lower, so the analysis considered that lower threshold. Recovery of the individual from eye damage or skin lesion caused by high energy lasers would be based on the severity of the injury and the incidence of secondary infection. Very few studies of this impact are available.

H.3.3 Long-Term Consequences to the Individual and Population

Long-term consequences are considered in terms of a resource's existing population level, growth and mortality rates, other stressors on the resource from the Proposed Action, cumulative impacts on the resource, and the ability of the population to recover from or adapt to impacts. Impacts of multiple or repeated stressors on individuals are cumulative. When stressors are chronic, an organism may experience reduced growth, health, or survival, which could have population-level impacts (Billard et al. 1981), especially in the case of endangered species.

H.4 Conceptual Framework for assessing Effects from Physical Disturbance or Strike

H.4.1 Stimuli

Size and Weight of the Objects

To determine the likelihood of a strike and the potential impacts on an organism or habitat that would result from a physical strike, the size and weight of the striking object relative to the organism or habitat must be considered. Most small organisms and early life stages would simply be displaced by the movement generated by a large object moving through, or falling into, the water because they are planktonic (floating organisms) and move with the water; however, animals that occur at or near the surface could be struck. A larger nonplanktonic organism could potentially be struck by an object since it may not be displaced by the movement of the water. Sessile (nonmobile) organisms and habitats could be struck by the object, albeit with less force, on the seafloor. The weight of the object is also a factor that would determine the severity of a strike. A strike by a heavy object would be more severe than a strike by a low-weight object (e.g., a decelerator/parachute, flare end cap, or chaff canister).

Location and Speed of the Objects

Evaluation of potential physical disturbance or strike risk considered the spatial overlap of the resource occurrence and potential striking objects. Analysis of impacts from physical disturbance or strike stressors focuses on proposed activities that may cause an organism or habitat to be struck by an object moving through the air (e.g., aircraft), water (e.g., vessels, in-water devices, towed devices), or dropped into the water (e.g., non-explosive practice munitions and seafloor devices). The area of operation, vertical distribution, and density of these items also play central roles in the likelihood of impact. Wherever appropriate, specific geographic areas of potential impact are identified. Analysis of potential physical disturbance or strike risk also considered the speed of vessels as a measure of intensity. Some vessels move slowly, while others are capable of high speeds.

Buoyancy of the Objects

Evaluation of potential physical disturbance or strike risk in the ocean considered the buoyancy of targets or expended materials during operation, which will determine whether the object will be encountered at the surface, within the water column, or on the seafloor. Once landed on the water surface, buoyant objects have the potential to strike plants and organisms that occur on the sea surface and negatively buoyant objects may strike plants and organisms within the water column or on the seafloor.

Behavior of the Organism

Evaluation of potential physical disturbance or strike risk considered where organisms occur and if they occur in the same geographic area and vertical distribution as those objects that pose strike risks.

H.4.2 Immediate Response and Costs to the Individual

Before being struck, some organisms would sense a pressure wave through the water and respond by remaining in place, moving away from the object, or moving toward it. An organism displaced a small distance by movements from an object falling into the water nearby would likely continue on with no response. However, others could be disturbed and may exhibit a generalized stress response. If the object actually hit the organism, direct injury in addition to stress may result. The function of the stress response in vertebrates is to rapidly raise the blood sugar level to prepare the organism to flee or fight. This generally adaptive physiological response can become a liability if the stressor persists and the organism cannot return to its baseline physiological state.

Most organisms would respond to sudden physical approach or contact by darting quickly away from the stimulus. Other species may respond by freezing in place or seeking refuge. In any case, the individual must stop whatever it was doing and divert its physiological and cognitive attention to responding to the stressor. The energy costs of reacting to a stressor depend on the specific situation, but in all cases the caloric requirements of stress reactions reduce the amount of energy available to the individual for other functions such as predator avoidance, reproduction, growth, and metabolism.

The ability of an organism to return to what it was doing following a physical strike (or near miss resulting in a stress response) is a function of fitness, genetic, and environmental factors. Some organisms are more tolerant of environmental or human-caused stressors than others and become acclimated more easily. Within a species, the rate at which an individual recovers from a physical disturbance or strike may be influenced by its age, sex, reproductive state, and general condition. An organism that has reacted to a sudden disturbance by swimming at burst speed would tire after some time; its blood hormone and sugar levels may not return to normal for 24 hours. During the recovery period, the organism may not be able to attain burst speeds and could be more vulnerable to predators. If the individual were not able to regain a steady state following exposure to a physical stressor, it may suffer depressed immune function and even death.

H.4.3 Long-Term Consequences to the Population

Long-term consequences are considered in terms of a resource's existing population level, growth and mortality rates, other stressors on the resource from the Proposed Action, cumulative impacts on the resource, and the ability of the population to recover from or adapt to impacts. Impacts of multiple or repeated stressors on individuals are cumulative. When stressors are chronic, an organism may experience reduced growth, health, or survival, which could have population-level impacts (Billard et al. 1981), especially in the case of endangered species.

H.5 Conceptual Framework for Assessing Effects from Entanglement

H.5.1 Stimuli

Physical Properties of the Objects

For an organism to become entangled in military expended materials, the materials must have certain properties, such as the ability to form loops and a high breaking strength. Some items could have a relatively low breaking strength on their own, but that breaking strength could be increased if multiple loops were wrapped around an entangled organism.

Location of the Objects

Evaluation of potential entanglement risk considered the spatial overlap of the resource occurrence and military expended materials. Distribution and density of expended items play a central role in the likelihood of impact. Wherever appropriate, specific geographic areas of potential impact are identified.

Buoyancy of Objects

Evaluation of potential entanglement risk considered the buoyancy of military expended materials to determine whether the object will be encountered within the water column (including the surface) or on the seafloor. Less buoyant materials, such as torpedo guidance wires, sink rapidly to the seafloor. More buoyant materials include less dense items (e.g., decelerators/parachutes) that are weighted and would sink slowly to the seafloor and could be entrained in currents.

Behavior of the Organism

Evaluation of potential entanglement risk considered the general behavior of the organism, including where the organism typically occurs (e.g., surface, water column, seafloor). The analysis particularly considered those species known to become entangled in nonmilitary expended materials (e.g., "marine debris") such as fishing lines, nets, rope, and other derelict fishing gear that often entangle marine organisms.

H.5.2 Immediate Response and Costs to the Individual

The potential impacts of entanglement on a given organism depend on the species and size of the organism. Species that have protruding snouts, fins, or appendages are more likely to become entangled than smooth-bodied organisms. Also, items could get entangled by an organism's mouth, if caught on teeth or baleen, with the rest of the item trailing alongside the organism. Materials similar to fishing gear, which is designed to entangle an organism, would be expected to have a greater entanglement potential than other materials. An entangled organism would likely try to free itself of the entangling object and in the process may become even more entangled, possibly leading to a stress response. The net result of being entangled by an object could be disruption of the normal behavior, injury due to lacerations, and other sublethal or lethal impacts.

H.5.3 Long-Term Consequences to the Individual and Population

Consequences of entanglement could range from an organism successfully freeing itself from the object or remaining entangled indefinitely, possibly resulting in lacerations and other sublethal or lethal impacts. Stress responses or infection from lacerations could lead to latent mortality. The analysis will focus on reasonably foreseeable long-term consequences of the direct impact, particularly those that could impact the fitness of an individual. Changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success could have population-level impacts if enough individuals are impacted. This population-level impact would vary among species and taxonomic groups.

H.6 Conceptual Framework for Assessing Effects from Ingestion

H.6.1 Stimuli

Size of the Objects

To assess the ingestion risk from military expended materials, this analysis considered the size of the object relative to the animal's ability to swallow it. Some items are too large to be ingested (e.g., non-explosive practice bombs and most targets) and impacts from these items are not discussed further. However, these items may potentially break down into smaller ingestible pieces over time. Items that are of ingestible size when they are introduced into the environment are carried forward for analysis within each resource section where applicable.

Location of the Objects

Evaluation of potential ingestion risk considered the spatial overlap of the resource occurrence and military expended materials. The distribution and density of expended items play a central role in the likelihood of impact. Wherever appropriate, specific geographic areas of potential impact were identified.

Buoyancy of the Objects

Evaluation of potential ingestion risk considered the buoyancy of military expended materials to determine whether the object will be encountered within the water column (including the surface) or on the seafloor. Less buoyant materials, such as solid metal materials (e.g., projectiles or ordnance fragments), sink rapidly to the seafloor. More buoyant materials include less dense items (e.g., target fragments and decelerators/parachutes) that may be caught in currents and gyres. These materials can remain in the water column for an indefinite period of time before sinking. However, decelerators/parachutes are weighted and would generally sink, unless that sinking is suspended, in the scenario described here.

Feeding Behavior

Evaluation of potential ingestion risk considered the feeding behavior of the organism, including where (e.g., surface, water column, seafloor) and how (e.g., filter feeding) the organism feeds and what it feeds on. The analysis particularly considered those species known to ingest nonfood items (e.g., plastic or metal items).

H.6.2 Immediate Response and Costs to the Individual

Potential impacts of ingesting foreign objects on a given organism depend on the species and size of the organism. Species that normally eat spiny hard-bodied invertebrates would be expected to have tougher mouths and guts than those that normally feed on softer prey. Materials similar in size and shape to the normal diet of an organism may be more likely to be ingested without causing harm to the animal; however, some general assumptions were made. Relatively small objects with smooth edges, such as shells or small-caliber projectiles, might pass through the digestive tract without causing harm. A small sharp-edged item may cause the individual immediate physical distress by tearing or cutting the mouth, throat, or stomach. If the object is rigid and large (relative to the individual’s mouth and throat), it may block the throat or obstruct digestive processes. An object may even be enclosed by a cyst in the gut lining. The net result of ingesting large foreign objects is disruption of the normal feeding behavior, which could be sublethal or lethal.

H.6.3 Long-Term Consequences to the Individual and Population

Consequences of ingesting nonfood items could be nutrient deficiency, bioaccumulation, uptake of toxic chemicals, compaction, and mortality. The analysis focused on reasonably foreseeable long-term consequences of the direct impact, particularly those that could impact the fitness of an individual. Changes in an individual’s growth, survival, annual reproductive success, or lifetime reproductive success could have population-level impacts if enough individuals were impacted. This population-level impact would vary among species and taxonomic groups.

REFERENCES

Bejder, L., Samuels, A., Whitehead, H., Finn, H. & Allen, S. (2009, December 3). Impact assessment research: use and misuse of habituation, sensitisation and tolerance in describing wildlife responses to anthropogenic stimuli. *Marine Ecology Progress Series, 395*, 177-185. 10.3354/meps07979 Retrieved from http://www.int-res.com/abstracts/meps/v395/p177-185/

Billard, R., Bry, C. & Gillet, C. (1981). Stress, environment and reproduction in teleost fish. A. D. Pickering (Ed.), *Stress and Fish*. New York: Academic Press Inc.

Crum, L., Bailey, M., Guan, J., Hilmo, P., Kargl, S. & Matula, T. (2005, July). Monitoring bubble growth in supersaturated blood and tissue *ex vivo* and the relevance to marine mammal bioeffects. *Acoustics Research Letters Online, 6*(3), 214-220. 10.1121/1.1930987

Crum, L. & Mao, Y. (1996, May). Acoustically enhanced bubble growth at low frequencies and its implications for human diver and marine mammal safety. *Acoustical Society of America, 99*(5), 2898-2907.

Henderson, D., Bielefeld, E. C., Harris, K. C. & Hu, B. H. (2006, January). The Role of Oxidative Stress in Noise-Induced Hearing Loss. *Ear & Hearing, 27*, 1-19.

Hennessy, M. B., Heybach, J. P., Vernikos, J. & Levine, S. (1979). Plasma corticosterone concentrations sensitively reflect levels of stimulus intensity in the rat. *Physiology and Behavior, 22*, 821-825.

Jensen, F., Bejder, L., Wahlberg, M., Aguilar Soto, N., Johnson, M. & Madsen, P. (2009, December 3). Vessel noise effects on delphinid communication. [electronic version]. *Marine Ecology Progress Series, 395*, 161-175. 10.3354/meps08204.

Jepson, P., Arbelo, M., Beaville, R., Patterson, I., Castro, P., Baker, J., . . . Fernandez, A. (2003, October). Gas-bubble lesions in stranded cetaceans Was sonar responsible for a spate of whale deaths after an Atlantic military exercise? *Nature, 425*.

Kujawa, S. G. & Liberman, M. C. (2009, November 11). Adding insult to injury: cochlear nerve degeneration after "temporary" noise-induced hearing loss. J Neurosci, 29(45), 14077-14085. 29/45/14077 [pii] 10.1523/JNEUROSCI.2845-09.2009 Retrieved from http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=19906956

Normandeau, Exponent, Tricas, T. & Gill, A. (2011). Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. Camarillo, CA: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region. Available from http://www.gomr.boemre.gov/PI/PDFImages/ESPIS/4/5115.pdf

Reeder, D. M. & Kramer, K. M. (2005, April). Stress in Free-Ranging Mammals: Integrating Physiology, Ecology, and Natural History. *Journal of Mammalogy, 86*(2), 225-235. Retrieved from http://www.jstor.org/stable/4094340?origin=JSTOR-pdf

Sies, H. (1997, December). Physiological Society Symposium: Impaired Endothelial and Smooth Muscle Cell Function in Oxidative Stress Oxidative Stress: Oxidants and Antioxidants. *Experimental Physiology, 82*, 291-295.

Slabbekoorn, H. and E. Ripmeester. (2008). "Birdsong and anthropogenic noise: implications and applications for conservation." Molecular Ecology 17(1): 72-83.

St. Aubin, D. J. & Dierauf, L. A. (2001). Stress and Marine Mammals L. A. Dierauf and F. M. D. Gulland (Eds.), *Marine Mammal Medicine* (second ed., pp. 253-269). Boca Raton: CRC Press.

Swope, B. (2010). Laser System Usage in the Marine Environment: Applications and Environmental Considerations. (Technical Report 1996, pp. 42) SPAWAR Systems Center PACIFIC.

Touyz, R. M. (2004). Reactive Oxygen Species, Vascular Oxidative Stress, and Redox Signaling in Hypertension: What Is the Clinical Significance? *Hypertension, 44*, 248-252. 10.1161/01.HYP.0000138070.47616.9d

Ulrich, R. (2004). *Development of a sensitive and specific biosensor assay to detect Vibrio vulnificus in estuarine waters.* (Partial fulfillment of the requirements for the degree of Master of Science Department of Biology college of Arts and Sciences). University of South Florida.

Zorn, H.M., Churnside, J.H. & Oliver, C.W. (2000). Laser safety thresholds for cetaceans and pinnipeds. Marine Mammal Science, 16(1): 186-200.

Appendix I: Acoustic and Explosives Primer

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

This Page Intentionally Left Blank

APPENDIX I ACOUSTIC AND EXPLOSIVES PRIMER

This section introduces acoustic principles and terminology describing how sound travels or "propagates" in air and water. These terms and concepts are used when analyzing potential impacts due to acoustic sources and explosives used during naval testing and training. This section briefly explains the transmission of sound; introduces some of the basic mathematical formulas used to describe the transmission of sound; and defines acoustical terms, abbreviations, and units of measurement. Because seawater is a very efficient medium for the transmission of sound, the differences between transmission of sound in water and in air are discussed. Finally, it discusses the various sources of underwater sound, including physical, biological, and anthropogenic sounds.

I.1 TERMINOLOGY/GLOSSARY

Sound is an oscillation in pressure, particle displacement, or particle velocity, as well as the auditory sensation evoked by these oscillations, although not all sound waves evoke an auditory sensation (i.e., they are outside of an animal's hearing range) (ANSI S1.1-1994). Sound may be described in terms of both physical and subjective attributes. Physical attributes may be directly measured. Subjective (or sensory) attributes cannot be directly measured and require a listener to make a judgment about the sound. Physical attributes of a sound at a particular point are obtained by measuring pressure changes as sound waves pass. The following material provides a short description of some of the basic parameters of sound.

I.1.1 PARTICLE MOTION AND SOUND PRESSURE

Sound is produced when a medium (air or water in this analysis) is set into motion, often by a vibrating object within the medium. As the object vibrates, its motion is transmitted to adjacent particles of the medium. The motion of these particles is transmitted to adjacent particles, and so on. As the sound wave travels through the medium, the individual particles of the medium oscillate about their original positions but do not actually move with the sound wave. The result is a mechanical disturbance (the "sound wave") that propagates away from the source. The measurable properties of a sound are the pressure oscillations of the sound wave and the velocity, displacement amplitude, and direction of particle movements. The basic unit of sound pressure is the Pascal (Pa) (1 Pa = 1.45×10^{-4} pounds per square inch), although the most commonly encountered unit is the micropascal (µPa) (1 µPa = 1×10^{6} megapascal).

Animals with an eardrum or similar structure directly detect the pressure component of sound. Some marine fish also have specializations to detect pressure changes. Certain animals (e.g., most invertebrates and some marine fish) likely cannot detect sound pressure, only the particle motion component of sound. Because particle motion is most detectable near a sound source and at lower frequencies, this difference in acoustic energy sensing mechanisms limits the range at which these animals can detect most sound sources analyzed in this document.

I.1.2 FREQUENCY

The number of oscillations or waves per second is called the frequency of the sound, and the metric is Hertz (Hz). One Hz is equal to one oscillation per second, and 1 kilohertz (kHz) is equal to 1,000 oscillations per second. The inverse of the frequency is the period or duration of one acoustic wave.

Frequency is the physical attribute most closely associated with the subjective attribute “pitch”; the higher the frequency, the higher the pitch. Human hearing generally spans the frequency range from 20 Hz to 20 kHz. The pitch based on these frequencies is subjectively “low” (at 20 Hz) or “high” (at 20 kHz).

Pure tones have a constant, single frequency. Complex tones contain multiple, discrete frequencies, rather than a single frequency. Broadband sounds are spread across many frequencies. The frequency range of a sound is called its bandwidth. A harmonic of a sound at a particular frequency is a multiple of that frequency (e.g., harmonic frequencies of a 2 kHz tone are 4 kHz, 6 kHz, 8 kHz, etc.). A source operating at a nominal frequency may emit several harmonic frequencies at much lower sound pressure levels.

In this document, sounds are generally described as either low- (less than 1 kHz), mid- (1 kHz–10 kHz), high- (greater than 10 kHz–100 kHz), or very high- (greater than 100 kHz) frequency. Hearing ranges of marine animals (e.g., fish, birds, and marine mammals) are quite varied and are species-dependent. For example, some fish can hear sounds below 100 Hz and some species of marine mammals have hearing capabilities that extend above 100 kHz. Discussions of sound and potential impacts must therefore focus not only on the sound pressure, but the composite frequency of the sound and the species considered.

I.1.3 Duty Cycle

Duty cycle describes the portion of time that a sound source actually generates sound. It is defined as the percentage of the time during which a sound is generated over a total operational period. For example, if a sound navigation and ranging (sonar) source produces a 10-second ping once every 100 seconds, the duty cycle is 10 percent. Duty cycles vary among different acoustic sources; in general, a low duty cycle is 20 percent or less and a high duty cycle is 80 percent or higher.

I.1.4 Loudness

Sound levels are normally expressed in decibels (dB), a commonly misunderstood term. Although the term decibel always means the same thing, decibels may be calculated in several ways, and the explanations of each can quickly become both highly technical and confusing.

Because mammalian ears can detect large pressure ranges and humans judge the relative loudness of sounds by the ratio of the sound pressures (a logarithmic behavior), sound pressure level is described by taking the logarithm of the ratio of the sound pressure to a reference pressure (American National Standards Institute 1994). Use of a logarithmic scale compresses the wide range of pressure values into a more usable numerical scale. (The softest audible sound has a power of about 0.000000000001 watt/square meter (m^2) and the threshold of pain is around 1 watt/m^2. With the advantage of the logarithmic scale, this ratio is efficiently described as 120 dB.)

On the decibel scale, the smallest audible sound (near total silence) is 0 dB. A sound 10 times more powerful is 10 dB. A sound 100 times more powerful than near total silence is 20 dB. A sound 1,000 times more powerful than near total silence is 30 dB. Table I-1 compares common sounds to their approximate decibel rating.

Table I-1: Common In-Air Sounds and their Approximate Decibel Ratings

Source	Source Level (dB re 20 µPa)
Near total silence	0 dB
Whisper	15 dB
Normal conversation	60 dB
Lawnmower	90 dB
Car horn	110 dB
Rock concert	120 dB
Gunshot	140 dB (peak)

Note: dB re 20 µPa = decibels referenced to 20 micropascals

I.2 PREDICTING HOW SOUND TRAVELS

Sounds are produced throughout a wide range of frequencies, including frequencies beyond the audible range of a given receptor. Most sounds heard in the environment do not consist of a single frequency, but rather a broad band of frequencies differing in sound level. The intensities of each frequency add to generate perceptible sound.

The speed of sound is not affected by its intensity, amplitude, or frequency, but rather depends wholly on characteristics of the medium through which it is passing. Sound generally travels faster as the density of the medium increases. Speeds of sound through air are primarily influenced by air temperature, relative humidity, and pressure, averaging about 1,115 feet per second (ft./s [340 meters {m}/s]) at standard barometric pressure. Sound speeds in air increase as air temperature increases. Sound travels differently in the water than in air because seawater is a very efficient medium for the transmission of sound. Sound moves at a faster speed in water, about 4,921 ft./s (1,500 m/s). The speed of sound through water is influenced by temperature, pressure, and salinity because sound travels faster as any of these parameters increase.

In the simple case of sound propagating from a point source without obstruction or reflection, the sound waves take on the shape of an expanding sphere. As spherical propagation continues, the sound energy is distributed over an ever-larger area following the inverse square law: the intensity of a sound wave decreases inversely with the square of the distance between the source and the receptor. For example, doubling the distance between the receptor and a sound source results in a reduction in the intensity of the sound of one-fourth of its initial value; tripling the distance results in one-ninth of the original intensity, and so on (Figure I-1). As expected, sound intensity drops at increasing distance from the point source. In spherical propagation, sound pressure levels drop an average of 6 dB for every doubling of distance from the source. Potential impacts on sensitive receptors, then, are directly related to the distance from the receptor to the noise source, and the intensity of the noise source itself.

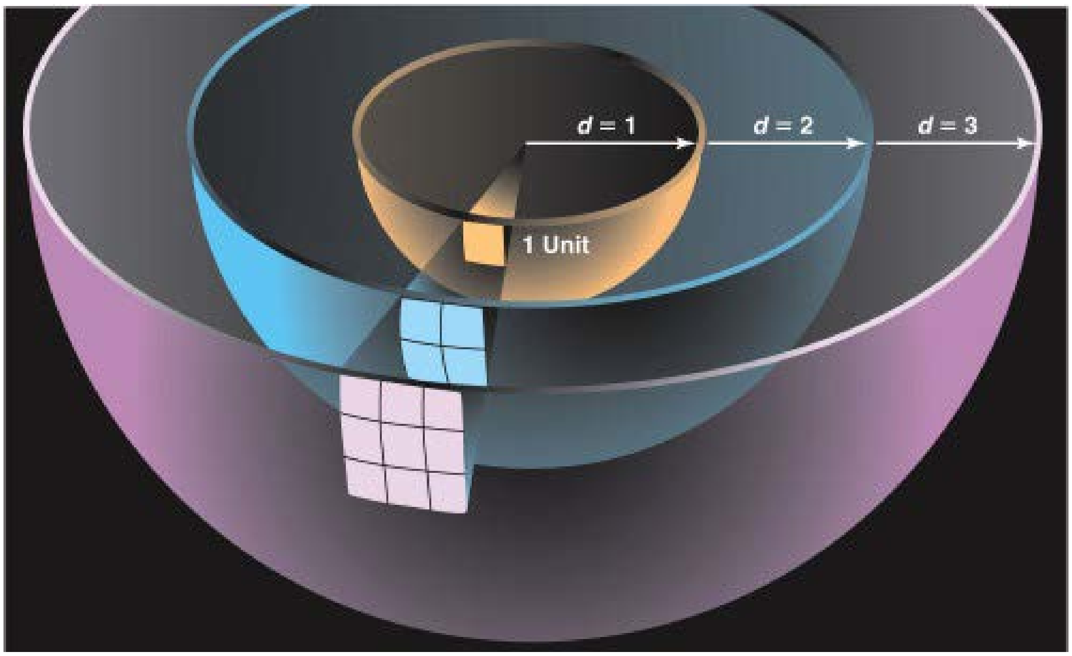


Figure I-1: Graphical Representation of the Inverse-Square Relationship in Spherical Spreading

While the concept of a sound wave traveling from its source to a receptor is relatively simple, sound propagation is quite complex because of the simultaneous presence of numerous sound waves of different frequencies and other phenomena such as reflections of sound waves and subsequent constructive (additive) or destructive (cancelling) interferences between reflected and incident waves. Other factors such as refraction, diffraction, bottom types, and surface conditions also affect sound propagation. While simple examples are provided here for illustration, the Navy Acoustic Effects Model used to quantify acoustic exposures to marine mammals and sea turtles takes into account the influence of multiple factors to predict acoustic propagation (Marine Species Modeling Team 2012).

I.2.1 Sound Attenuation and Transmission Loss

As a sound wave passes through a medium, the intensity decreases with distance from the sound source. This phenomenon is known as attenuation or propagation loss. Sound attenuation may be described in terms of transmission loss (TL). The units of transmission loss are dB. The transmission loss is used to relate the source level (SL), defined as the sound pressure level produced by a sound source at a distance of 3.3 ft. (1 m), and the received level (RL) at a particular location, as follows:

$$RL = SL - TL$$

The main contributors to sound attenuation are as follows:

- Geometrical spreading of the sound wave as it propagates away from the source
- Sound absorption (conversion of sound energy into heat)
- Scattering, diffraction, multipath interference, boundary effects
- Other nongeometrical effects (Urick 1983)

I.2.2 SPREADING LOSS

Spreading loss is a geometrical effect representing regular weakening of a sound wave as it spreads out from a source (Campbell et al. 1988). Spreading describes the reduction in sound pressure caused by the increase in surface area as the distance from a sound source increases. Spherical and cylindrical spreading are common types of spreading loss.

As described before, a point sound source in a homogeneous medium without boundaries will radiate spherical waves—the acoustic energy spreads out from the source in the form of a spherical shell. As the distance from the source increases, the shell surface area increases. If the sound power is fixed, the sound intensity must decrease with distance from the source (intensity is power per unit area). The surface area of a sphere is $4\pi r^2$, where r is the sphere radius, so the change in intensity is proportional to the radius squared. This relationship is known as the spherical spreading law. The transmission loss for spherical spreading is:

$$TL = 20\log_{10} r$$

where *r* is the distance from the source. This is equivalent to a 6 dB reduction in sound pressure level for each doubling of distance from the sound source. For example, calculated transmission loss for spherical spreading is 40 dB at 328.1 ft. (100 m) and 46 dB at 656.2 ft. (200 m).

In cylindrical spreading, spherical waves expanding from the source are constrained by the water surface and the seafloor and take on a cylindrical shape. In this case the sound wave expands in the shape of a cylinder rather than a sphere and the transmission loss is:

$$TL = 10\log_{10} r$$

Cylindrical spreading is an approximation to wave propagation in a water-filled channel with horizontal dimensions much larger than the depth. Cylindrical spreading predicts a 3 dB reduction in sound pressure level for each doubling of distance from the source. For example, calculated transmission loss for cylindrical spreading is 20 dB at 328.1 ft. (100 m) and 23 dB at 656.2 ft. (200 m).

I.2.2.1 Reflection and Refraction

When a sound wave propagating in a medium encounters a second medium with a different density or sound speed (e.g., the air-water boundary) part of the incident sound will be reflected back into the first medium and part will be transmitted into the second medium (Kinsler et al. 1982). If the second medium has a different sound speed than the first, the propagation direction will change as the sound wave enters the second medium; this phenomenon is called refraction. Refraction may also occur within a single medium if the sound speed varies in the medium.

Refraction of sound resulting from spatial variations in the sound speed is one of the most important phenomena that affect sound propagation in water (Urick 1983). The sound speed in the ocean primarily depends on hydrostatic pressure (i.e., depth) and temperature. Sound speed increases with both hydrostatic pressure and temperature. In seawater, temperature has the most important effect on sound speed for depths less than about 984.2 ft. (300 m). Below 4,921.3 ft. (1,500 m), the hydrostatic pressure is the dominant factor because the water temperature is relatively constant. The variation of sound speed with depth in the ocean is called a sound speed profile.

Although the actual variations in sound speed are small, the existence of sound speed gradients in the ocean has an enormous effect on the propagation of sound in the ocean. If one pictures sound as rays emanating from an underwater source, the propagation of these rays changes as a function of the sound speed profile in the water column. Specifically, the directions of the rays bend toward regions of slower sound speed. This phenomenon creates ducts in which sound becomes "trapped," allowing it to propagate with high efficiency for large distances within certain depth boundaries. During winter months, the reduced sound speed at the surface due to cooling can create a surface duct that efficiently propagates sound such as shipping noise. The deep sound channel or Sound Frequency and Ranging channel is another duct that exists where sound speeds are lowest in the water column (1,968.5 ft.–3,937 ft. [600 m–1,200 m] depth at the mid-latitudes). Intense low-frequency underwater sounds, such as explosions, can be detected halfway around the world from their source via the Sound Frequency and Ranging channel (Baggeroer and Munk 1992).

I.2.2.2 Diffraction, Scattering, and Reverberation

Sound waves experience diffraction in much the same manner as light waves. Diffraction may be thought of as the bending of a sound wave around an obstacle. Common examples include sound heard from a source around the corner of a building and sound propagating through a small gap in an otherwise closed door or window. An obstacle or inhomogeneity (e.g., smoke, suspended particles, or gas bubbles) in the path of a sound wave causes scattering if secondary sound spreads out from it in a variety of directions (Pierce 1989). Scattering is similar to diffraction. Normally diffraction is used to describe sound bending or scattering from a single object, and scattering is used when there are multiple objects. Reverberation, or echo, refers to the prolongation of a sound that occurs when sound waves in an enclosed space are repeatedly reflected from the boundaries defining the space, even after the source has stopped emitting.

I.2.2.3 Multipath Propagation

In multipath propagation, sound may not only travel a direct path from a source to a receiver, but also be reflected from the surface or bottom multiple times before reaching the receiver (Urick 1983). At some distances, the reflected wave will be in phase with the direct wave (their waveforms add together) and at other distances the two waves will be out of phase (their waveforms cancel). The existence of multiple sound paths, or rays, arriving at a single point can result in multipath interference, a condition that permits the addition and cancellation between sound waves resulting in the fluctuation of sound levels over short distances. A special case of multipath propagation loss is called the Lloyd mirror effect, where the sound field near the water's surface reaches a minimum because of the destructive interference (cancellation) between the direct sound wave and the sound wave being reflected from the surface. This can cause the sound level to decrease dramatically within the top few meters of the water column.

I.2.2.4 Surface and Bottom Effects

Because the sea surface reflects and scatters sound, it has a major effect on the propagation of underwater sound in applications where either the source or receiver is at a shallow depth (Urick 1983). If the sea surface is smooth, the reflected sound pressure is nearly equal to the incident sound pressure; however, if the sea surface is rough, the amplitude of the reflected sound wave will be reduced.

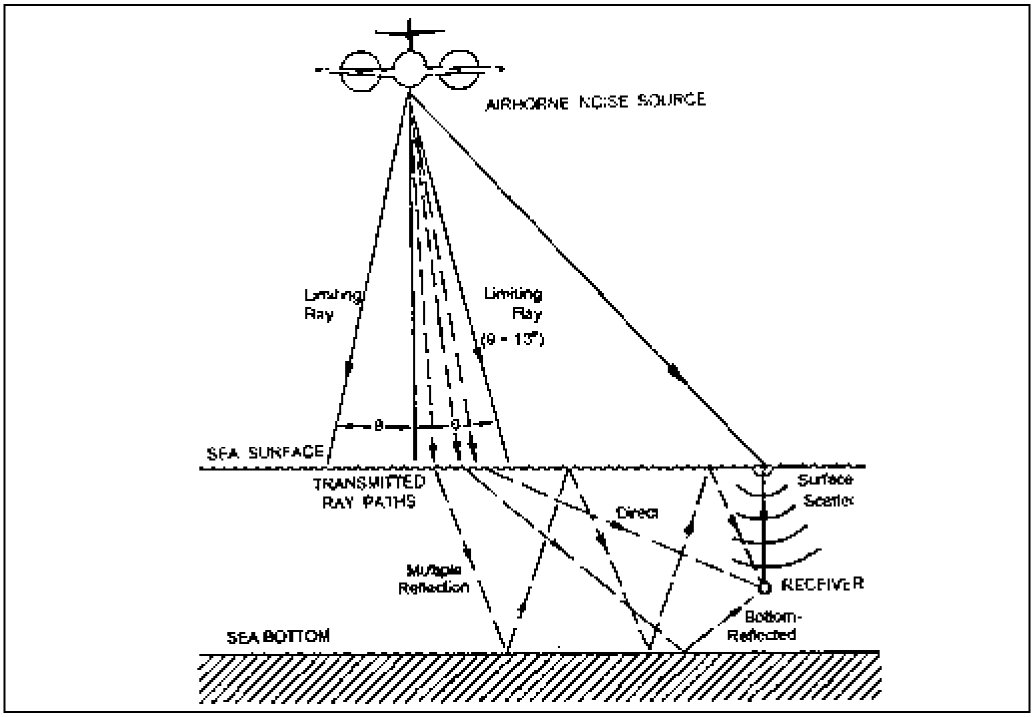
The sea bottom is also a reflecting and scattering surface, similar to the sea surface. Sound interaction with the sea bottom is more complex, however, primarily because the acoustic properties of the sea bottom are more variable and the bottom is often layered into regions of differing density and sound speed. The Lloyd mirror effect may also be observed from sound sources located near the sea bottom. For a hard bottom such as rock, the reflected wave will be approximately in phase with the incident wave. Thus, near the ocean bottom, the incident and reflected sound pressures may add together, resulting in an increased sound pressure near the sea bottom.

I.2.2.5 Air-Water Interface

Sound from aerial sources such as aircraft, muzzle blasts, and projectile sonic booms, can be transmitted into the water. The most studied of these sources are fixed-wing aircraft and helicopters, which create noise with most energy below 500 Hz. Noise levels in water are highest at the surface and are highly dependent on the altitude of the aircraft and the angle at which the aerial sound encounters the ocean surface. Transmission of the sound once it is in the water is identical to any other sound as described in the section above.

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been addressed by Young (1973), Urick (1983), Richardson et al. (1995), Eller and Cavanagh (2000), Laney and Cavanagh (2000), and others. Sound is transmitted from an airborne source to a receptor underwater by four principal means: (1) a direct path, refracted upon passing through the air-water interface; (2) direct-refracted paths reflected from the bottom in shallow water; (3) evanescent transmission in which sound travels laterally close to the water surface; and (4) scattering from interface roughness due to wave motion.

Airborne sound is refracted upon transmission into water because sound waves move faster through water than through air (a ratio of about 0.23:1). Based on this difference, the direct sound path is reflected if the sound reaches the surface at an angle more than 13° from vertical. As a result, most of the acoustic energy transmitted into the water from an aircraft arrives through a relatively narrow cone extending vertically downward from the aircraft (Figure I-2). The intersection of this cone with the surface traces a “footprint” directly beneath the flight path, with the width of the footprint being a function of aircraft altitude. Sound may enter the water outside of this cone due to surface scattering and as evanescent waves, which travel laterally near the water surface.



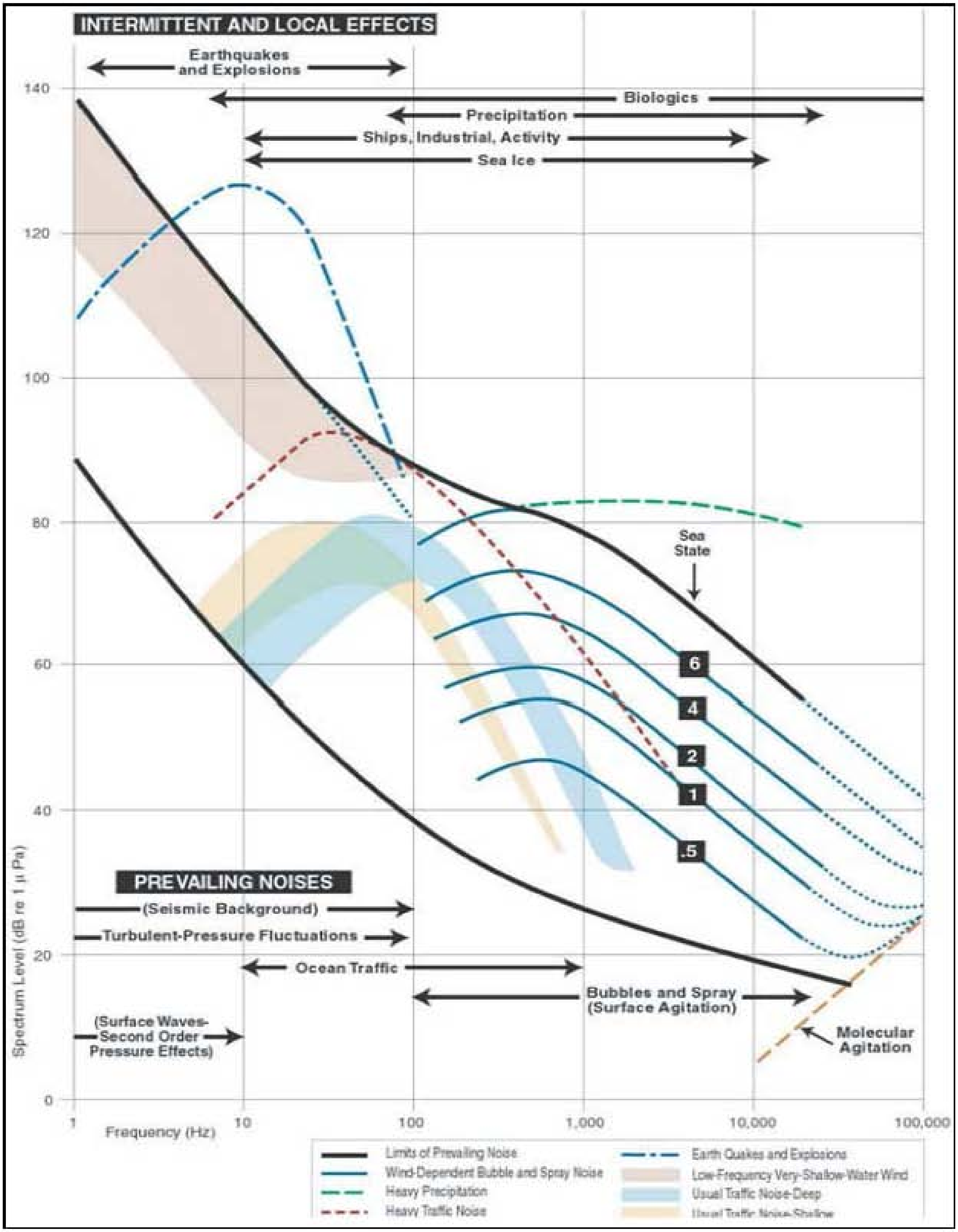
Source: Richardson et al. 1995

Figure I-2: Characteristics of Sound Transmission through the Air-Water Interface

The sound pressure field is actually doubled (+6 dB) at the air-to-water interface because of the large difference in the acoustic properties of water and air. For example, an airborne sound with a sound pressure level of 100 dB re 1 µPa at the sea surface becomes 106 dB re 1 µPa just below the surface. The pressure and sound levels then decrease with increasing distance as they would for any other in-water noise.

I.3 SOURCES OF SOUND

Ambient noise is the collection of ever-present sounds of both natural and human-generated origin. Ambient noise in the ocean comprises sound generated by natural physical, natural biological, and anthropogenic (human-generated) sources (Figure I-3). Preindustrial physical and biological noise sources in marine environments were often not high enough to interfere with the hearing of marine animals (Richardson et al. 1995). However, the increase in anthropogenic noise sources in recent times is a concern.



Source: National Research Council (2003), adapted from Wenz (1962)

Figure I-3: Oceanic Ambient Noise Levels from 1 Hertz to 100,000 Hertz, Including Frequency Ranges for Prevalent Noise Sources

Except for some sounds generated by marine mammals, most natural ocean sound is broadband (composed of a spectrum of numerous frequencies). Virtually the entire frequency spectrum is represented in ambient sound sources as shown in Figure I-3 (National Research Council 2003, adapted from Wenz 1962). Earthquakes and explosions produce sound signals from 1 Hz to 100 Hz; marine species can produce signals from 100 Hz to more than 10,000 Hz; and commercial shipping, industrial activities, and naval ships have signals between 10 Hz and 10,000 Hz (Figure I-3). Spray and bubbles associated with breaking waves are the major contributors to the ambient sound in the 500 Hz to 100,000 Hz range. At frequencies greater than 100,000 Hz, "thermal noise" caused by the random motion of water molecules is the primary source. Natural sources, especially from wave and tidal action, can cause coastal environments to have particularly high ambient sound levels.

I.3.1 UNDERWATER SOUNDS

Physical, biological, and anthropogenic sounds all contribute to the ambient underwater noise environment. Example source levels for various underwater sounds are shown in Table I-2. Many naturally occurring sounds have source levels similar to anthropogenic sounds.

Table I-2: Source Levels of Common Underwater Sounds

Source	Source Level (dB re 1 μPa at 1 m)
Ice breaker ship	193[1]
Large tanker	186[1]
Seismic airgun array (32 guns)	259 (peak)[1]
Dolphin whistles	125–173[1]
Dolphin clicks	194–219[2]
Humpback whale song	144–174[3]
Snapping shrimp	183–189[4]
Sperm whale click	236[5]
Naval mid-frequency active sonar (SQS-53)	235
Lightning strike	260[6]
Seafloor volcanic eruption	255[7]

[1] Richardson et al. 1995, [2] Rasmussen et al. 2002, [3] Payne and Payne 1985; Thompson et al. 1979, [4] Au and Banks 1998, [5] Levenson 1974; Watkins 1980, [6] Hill 1985, [7] Northrop 1974

Note: dB re 1 μPa at 1 m = decibels referenced to 1 micropascal at 1 meter

I.3.2 PHYSICAL SOURCES OF UNDERWATER SOUND

Physical processes that create sound in the ocean include rain, wind, waves, sea ice, lightning strikes at the sea surface, undersea earthquakes, and eruptions from undersea volcanoes. Generally, these sound sources contribute to a rise in the ambient sound levels on an intermittent basis. Underwater sound from rain typically is between 1 and 10 kHz. Wind produces frequencies between 100 Hz and 30 kHz, while wave-generated sound is a significant contributor in the infrasonic range (i.e., 1 to 20 Hz) (Simmonds et al. 2003). Seismic activity results in the production of low-frequency sounds that can be heard for great distances.

I.3.3 BIOLOGICAL SOURCES OF UNDERWATER SOUND

Marine animals use sound both passively and actively to navigate, communicate, locate food, reproduce, and detect predators and other important environmental cues. Sounds produced by marine species can increase ambient sound levels by nearly 20 dB over the range of a few kHz (e.g., crustaceans and fish) or over the range of tens to hundreds of kHz (e.g., dolphin clicks and whistles). For example, reproductive activity, including courtship and spawning, accounts for the majority of sounds produced by fish. During the spawning season, croakers (family Sciaenidae) vocalize for many hours and often dominate the acoustic environment (Ramcharitar et al. 2006). Other species, including baleen whales (Mysticetes) and toothed whales and dolphins (Odontocetes) produce a wide variety of sounds in many different behavioral contexts. These sounds can include tonal calls, clicks, whistles, and pulsed sounds, which cover a wide range of frequencies depending on the species and sound type produced. For instance, bottlenose dolphin clicks and whistles have a dominant frequency range of 110 to 130 kHz and 3.5 to 14.5 kHz, respectively (Au 1993). In addition, sperm whale clicks range in frequency from 0.1 kHz to 30 kHz, with dominant energy in two bands (2 to 4 kHz and 10 to 16 kHz) (Richardson et al. 1995). Blue and fin whales produce low-frequency moans at frequencies of 10 to 25 Hz. Colonies of snapping shrimp can generate sounds at frequencies of 2 to 15 kHz.

I.3.4 ANTHROPOGENIC SOURCES OF UNDERWATER SOUND

In addition to sounds generated during Navy training and testing, other non-Navy activities also introduce similar types of anthropogenic (human-generated) sound into the ocean from a number of sources, including non-military vessel traffic, industrial operations onshore (pile driving), seismic profiling for oil exploration, oil drilling, underwater explosions, and in-air sources that can enter the water. Noise levels resulting from human activities in coastal and offshore areas are increasing; however, there are few historical records of ambient noise data to substantiate the level of increase. Some studies have documented increases in ambient noise off California over the last several decades (Andrew et al. 2002, McDonald et al. 2006, McDonald et al. 2008).

Commercial shipping is the most widespread source of human-made, low-frequency (0 to 1,000 Hz) noise in the oceans and may contribute more than 75 percent of all human-made sound in the sea (International Council for the Exploration of the Sea 2005), particularly in coastal areas and near shipping lanes (see Figure 3.12-1 for commercial shipping lanes in the Study Area). There are approximately 20,000 large commercial vessels at sea worldwide at any given time. Because low-frequency sounds carry for long distances, a large vessel emitting sound at 6.8 Hz can be detected 75–250 nautical miles away (Polefka 2004). The dominant component of low-frequency ambient noise is commercial tankers, which contribute twice as much noise as cargo vessels and at least 100 times as much noise as research vessels (Hatch et al. 2008). Most of these sounds are produced as a result of propeller cavitation (when air spaces created by the motion of propellers collapse) (Southall et al. 2007).

High-intensity, low-frequency impulse sounds are emitted during seismic surveys to determine the structure and composition of the geological formations below the sea bed to identify potential hydrocarbon reservoirs (i.e., oil and gas exploration) (Simmonds et al. 2003).

I.3.5 AERIAL SOUNDS

Aerial sounds may be produced by physical, biological, or anthropogenic sources. These sounds may be transmitted across the air-water interface as well. Of the physical sources of sound, surf noise is one of the most dominant. The highest sound levels from surf are typically low frequency (below 100 Hz). Biological sources of sound can be a significant contribution to the noise level in coastal environments such as areas occupied by highly vocal sea lions. Anthropogenic noise sources like ships, industrial sites, cars, and airplanes are also potential contributors.

I.3.6 NAVY SOURCES OF SOUND IN THE WATER

Many of the Navy's proposed activities may introduce sound into the ocean. The type of sound will determine how that source is measured and evaluated for potential impacts to the environment. All of the Navy-produced sounds may be categorized as impulse or non-impulse. Impulse sounds feature a very rapid increase to high pressures, followed by a rapid return to the static pressure. Impulse sounds are often produced by processes involving a rapid release of energy or mechanical impacts (Hamernik and Hsueh 1991). Non-impulse sounds lack the rapid rise time and can have longer durations than impulse sounds. Non-impulse sound can be continuous or intermittent. See Figure I-4 for examples of impulse and non-impulse underwater sound sources.

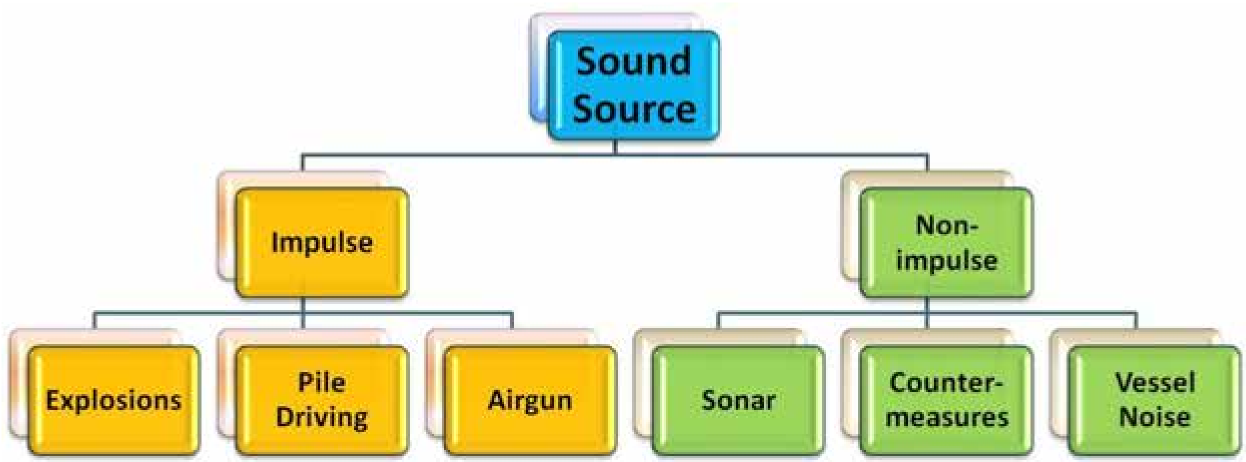


Figure I-4: Examples of Impulse and Non-impulse Sound Sources

I.4 SOUND METRICS

I.4.1 PRESSURE

Various sound pressure metrics are illustrated in Figure I-5 for a (a) non-impulse, and (b) an impulse sound. Sound pressure varies differently with time for non-impulse and impulse sounds. As shown in Figure I-5, the non-impulse sound has a relatively gradual rise in pressure from static pressure (the ambient pressure without the added sound), while the impulse sound has a near-instantaneous rise to a higher peak pressure. The peak pressure shown on both illustrations is the maximum absolute value of the instantaneous sound pressure during a specified time interval, which accounts for the values of peak pressures below the static (ambient) pressure (American National Standards Institute 1994). Peak-to-peak pressure is the difference between the maximum and minimum sound pressures. The root-mean-squared sound pressure is often used to describe the average pressure level of sounds. As the name suggests, this method takes the square root of the average squared sound pressure values over a time interval. The duration of this time interval can have a strong effect on the measured root-mean-squared sound pressure for a given sound, especially where pressure levels vary significantly, as during an impulse. If the analysis duration includes a significant portion of the waveform after the impulse has ended and the pressure has returned to near static, the root-mean-squared level would be relatively low. If the analysis duration includes the highest pressures of the impulse and excludes the portion of the waveform after the impulse has terminated, the root-mean-squared level would be comparatively high. For this reason, it is important to specify the duration used to calculate the root-mean-squared pressure for impulse sounds.

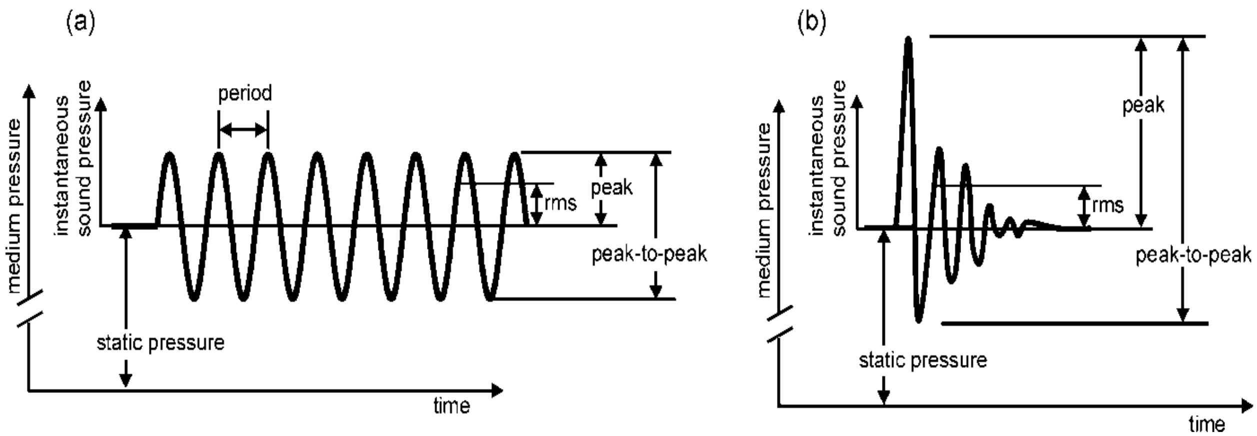


Figure I-5: Various Sound Pressure Metrics for a Hypothetical (a) Pure Tone (Non-Impulse) and (b) Impulse Sound

I.4.2 SOUND PRESSURE LEVEL

Because mammalian ears can detect large pressure ranges and humans judge the relative loudness of sounds by the ratio of the sound pressures (a logarithmic behavior), sound pressure level is described by taking the logarithm of the ratio of the sound pressure to a reference pressure (American National Standards Institute 1994). Use of a logarithmic scale compresses the wide range of pressure values into a more usable numerical scale.

Sound levels are normally expressed in dB. To express a pressure X in decibels using a reference pressure X_{ref}, the equation is:

$$20\log_{10}\left(\frac{X}{X_{ref}}\right)$$

The pressure X is the root-mean-square value of the pressure. When a value is presented in decibels, it is important to specify the value and units of the reference pressure. Normally the decibel value is given, followed by the text “re,” meaning “with reference to,” and the value and unit of the reference pressure. The standard reference pressures are 1 µPa for water and 20 µPa for air (American National Standards Institute 1994). It is important to note that, because of the difference in reference units between air and water, the same absolute pressures would result in different dB values for each medium.

I.4.3 SOUND EXPOSURE LEVEL

When analyzing effects on marine animals from multiple moderate-level sounds, it is necessary to have a metric that quantifies cumulative exposure(s) (American National Standards Institute 1994). The Sound Exposure Level (SEL) can be thought of as a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events (e.g., a series of sonar pings) have two main characteristics: (1) a sound level that changes throughout the event and (2) a period of time during which the source is exposed to the sound. Cumulative SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Sound exposure level is determined by calculating the decibel level of the cumulative sum-of-squared pressures over the duration of a sound, with units of dB re 1 µPa-squared second (µPa^2-s) for sounds in water.

Some rules of thumb for SEL are as follows:

- The numeric value of SEL is equal to the sound pressure level of a one-second sound that has the same total energy as the exposure event. If the sound duration is one second, sound pressure level and SEL have the same numeric value (but not the same reference quantities). For example, a one-second sound with a sound pressure level of 100 dB re 1 µPa has a SEL of 100 dB re 1 µPa^2-s.
- If the sound duration is constant but the sound pressure level changes, SEL will change by the same number of decibels as the sound pressure level.
- If the sound pressure level is held constant and the duration (T) changes, SEL will change as a function of $10\log_{10}(T)$:
    - o $10\log_{10}(10) = 10$, so increasing duration by a factor of 10 raises SEL by 10 dB.
    - o $10\log_{10}(0.1) = –10$, so decreasing duration by a factor of 10 lowers SEL by 10 dB.
    - o Since $10\log_{10}(2) \approx 3$, so doubling the duration increases SEL by 3 dB.
    - o $10\log_{10}(1/2) \approx -3$, so halving the duration lowers SEL by 3 dB.

Figure I-6 illustrates the summation of energy for a succession of sonar pings. In this hypothetical case, each ping has the same duration and sound pressure level. The SEL at a particular location from each individual ping is 100 dB re 1 µPa^2-s (red circles). The upper, blue curve shows the running total or cumulative SEL.

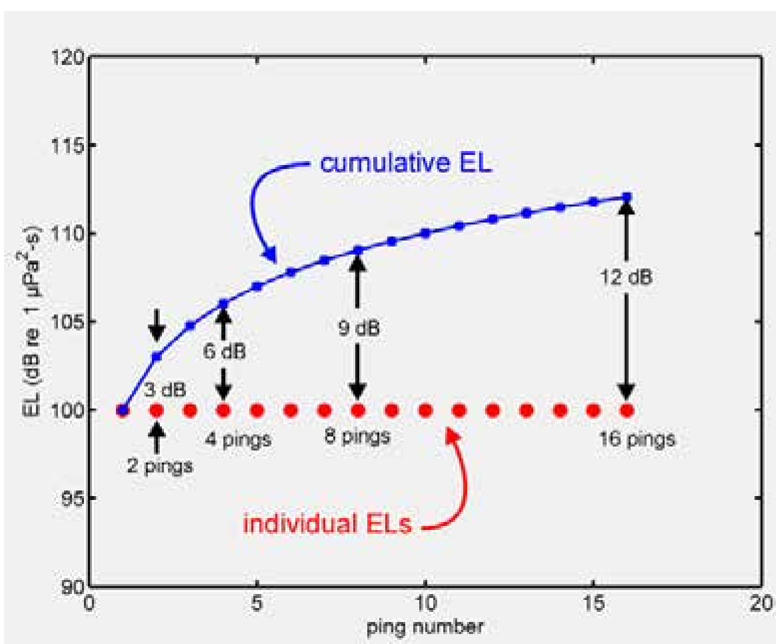


Figure I-6: Summation of Acoustic Energy (Cumulative Exposure Level, or Sound Exposure Level) from a Hypothetical, Intermittently Pinging, Stationary Sound Source (EL = Exposure Level)

After the first ping, the cumulative SEL is 100 dB re 1 μPa^2-s. Since each ping has the same duration and sound pressure level, receiving two pings is the same as receiving a single ping with twice the duration. The cumulative SEL from two pings is therefore 103 dB re 1 μPa^2-s. The cumulative SEL from four pings is 3 dB higher than the cumulative SEL from two pings, or 106 dB re 1 μPa^2-s. Each doubling of the number of pings increases the cumulative SEL by 3 dB.

Figure I-7 shows a more realistic example where the individual pings do not have the same sound pressure level or SEL. These data were recorded from a stationary hydrophone as a sound source approached, passed, and moved away from the hydrophone. As the source approached the hydrophone, the received sound pressure level from each ping increased, causing the SEL of each ping to increase. After the source passed the hydrophone, the received sound pressure level and SEL from each ping decreased as the source moved farther away (downward trend of red line), although the cumulative SEL increased with each additional ping received (slight upward trend of blue line). The main contributions are from those pings with the highest individual SELs. Individual pings with SELs 10 dB or more below the ping with the highest level contribute little (less than 0.5 dB) to the total cumulative SEL. This is shown in Figure I-7 where only a small error is introduced by summing the energy from the eight individual pings with SEL greater than 185 dB re 1 μPa^2-s (black line), as opposed to including all pings (blue line).

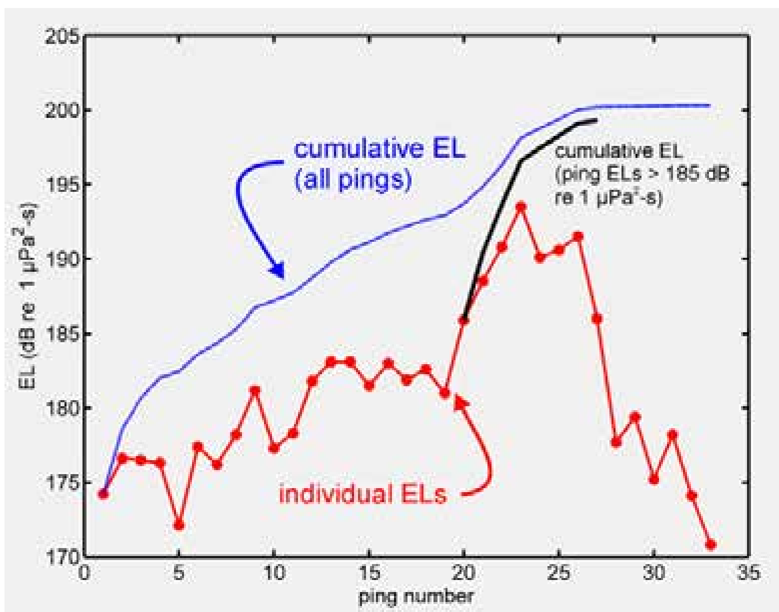


Figure I-7: Cumulative Sound Exposure Level under Realistic Conditions with a Moving, Intermittently Pinging Sound Source (Cumulative Exposure Level = Sound Exposure Level)

Impulse (Pascal-seconds)

Impulse is a metric used to describe the pressure and time component of an intense shock wave from an explosive source. The impulse calculation takes into account the magnitude and duration of the initial peak positive pressure, which is the portion of an impulse sound most likely to be associated with damage. Specifically, impulse is the time integral of the initial peak positive pressure with units Pascal-seconds. The peak positive pressure for an impulse sound is shown in Figure I-5 as the first and largest pressure peak above static pressure. This metric is used to assess potential injurious effects from explosives.

I.4.4 AUDITORY WEIGHTING FUNCTIONS

Animals, including humans, are not equally sensitive to sounds across their entire hearing range. The subjective judgment of a sound level by a receiver such as an animal is known as loudness. Two sounds received at the same sound pressure level (an objective measurement), but at two different frequencies, may be perceived by an animal at two different loudness levels depending on its hearing sensitivity (lowest sound pressure level at which a sound is first audible) at the two different frequencies. Furthermore, two different species may judge the relative loudness of the two sounds differently.

Auditory weighting functions are a method common in human hearing risk analysis to account for differences in hearing sensitivity at various frequencies. This concept can be applied to other species as well. When used in analyzing the impacts of sound on an animal, auditory weighting functions adjust received sound levels to emphasize ranges of best hearing and de-emphasize ranges of less or no sensitivity. A-weighted sound levels, often seen in units of “dBA,” (A-weighted decibels) are frequency-weighted to account for the sensitivity of the human ear to a barely audible sound. Many measurements of sound in air appear as A-weighted decibels in the literature because the intent of the authors is often to assess noise impacts on humans.

REFERENCES

Andrew, R. K., Howe, B. M., Mercer, J. A., & Dzieciuch, M. A. (2002). Ocean ambient sound: comparing the 1960s with the 1990s for a receiver off the California coast. Acoustics Research Letters Online, 3, 65.

American National Standards Institute. (1994). ANSI S1.1-1994 (R 2004) American National Standard Acoustical Terminology (Vol. S1.1-1994 (R 2004)). New York, NY: Acoustical Society of America.

Au, W. W. L. (1993). The Sonar of Dolphins (pp. 227). New York: Springer-Verlag.

Au, W. W. L. & Banks, K. (1998). The acoustics of the snapping shrimp *Synalpheus parneomeris* in Kaneohe Bay. *Journal of the Acoustical Society of America, 103*(1), 41-47.

Baggeroer, A. & Munk, W. (1992). The Heard Island feasibility test. *Physics Today*, 22-30.

Campbell, R. R., Yurick, D. B. & Snow, N. B. (1988). Predation on narwhals, *Monodon monoceros*, by killer whales, *Orcinus orca*, in the Eastern Canadian Arctic. *Canadian Field-Naturalist, 102*(4), 689-696.

Eller, A. I. & Cavanagh, R. C. (15118). (2000). Subsonic aircraft noise at and beneath the ocean surface: estimation of risk for effects on marine mammals. (Vol. AFRL-HE-WP-TR-2000-0156).

Gallo-Reynoso, J. P., Egido-Villarreal, J., and Martinez-Villalba, G. L. (2011). Reaction of Fin Whales Balaenoptera Physalus to an earthquake. Bioacoustics. The International Journal of Animal Sound and its Recording. 20: pp. 317-330.

Hamernik, R. P. & Hsueh, K. D. (1991). Impulse noise: some definitions, physical acoustics and other considerations. [special]. *Journal of the Acoustical Society of America, 90*(1), 189-196.

Hatch, L., Clark, C., Merrick, R., Van Parijs, S., Ponirakis, D., Schwehr, K., Wiley, D. (2008). Characterizing the relative contributions of large vessels to total ocean noise fields: A case study using the Gerry E. Studds Stellwagen Bank National Marine Sanctuary. *Environmental Management, 42*, 735-752. doi:10.1007/s00267-008-9169-4

Hill, R.D. (1985). Investigation of lightning strikes to water surfaces. *Journal of the Acoustical Society of America*, 78(6), 2096-2099.

International Council for the Exploration of the Sea. (2005). *Answer to DG Environment Request on Scientific Information Concerning Impact of Sonar Activities on Cetacean Populations*. (pp. 6). Copenhagen, Denmark: International Council for the Exploration of the Sea. Available from European Commission website: http://ec.europa.eu/environment/nature/conservation/species/whales_dolphins/

Kinsler, L. E., Frey, A. R., Coppens, A. B. & Sanders, J. V. (1982). Fundamentals of Acoustics (3rd ed.). New York, NY: Wiley.

Laney, H. & Cavanagh, R. C. (15117). (2000). Supersonic aircraft noise at and beneath the ocean surface: estimation of risk for effects on marine mammals. (Vol. AFRL-HE-WP-TR-2000-0167, pp. 1-38).

Levenson, C. (1974). Source level and bistatic target strength of the sperm whale (*Physeter catodon*) measured from an oceanographic aircraft. *Journal of the Acoustical Society of America, 55*(5), 1100-1103.

Marine Species Modeling Team. (2012). Determination of Acoustic Effects on Marine Mammals and Sea Turtles for the Atlantic Fleet Training and Testing Environmental Impact Statement/Overseas

Environmental Impact Statement. (NUWC-NPT Technical Report 12,071) Naval Undersea Warfare Command Division, Newport.

McDonald, M. A., Hildebrand, J. A., & Wiggins, S. M. (2006). Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California.

McDonald, M. A., Hildebrand, J. A., Wiggins, S. M., & Ross, D. (2008). A 50 year comparison of ambient ocean noise near San Clemente Island: A bathymetrically complex coastal region off southern California. The Journal of the Acoustical Society of America, 124, 1985.

National Research Council. (2003). Ocean Noise and Marine Mammals. Ocean Studies Board, National Research Council, The National Academies Press, Washington, DC. pp. 39.

Northrop, J. (1974). Detection of low-frequency underwater sounds from a submarine volcano in the Western Pacific. *Journal of the Acoustical Society of America*, 56(3), 837-841.

Payne, K. & Payne, R. (1985). Large scale changes over 19 years in songs of humpback whales in Bermuda. *Zeitschrift fur Tierpsychologie 68*, 89-114.

Pierce, A.D. (1989). Acoustics: An introduction to its physical principles and applications. Woodbury, NY: *Acoustical Society of America*.

Polefka, S. (2004). *Anthropogenic Noise and the Channel Islands National Marine Sanctuary: How Noise Affects Sanctuary Resources, and What We Can Do About It*. (pp. 51). Santa Barbara, CA: Environmental Defense Center. Available from Channel Islands National Marine Sanctuary website: http://www.channelislands.noaa.gov/sac/report_doc.html

Ramcharitar, J., Gannon, D. & Popper, A. (2006). Bioacoustics of fishes of the family Sciaenidae (croakers and drums). *Transactions of the American Fisheries Society, 135*, 1409-1431.

Rasmussen, M. H., Miller, L. A. & Au, W. W. L. (2002). Source levels of clicks from free-ranging white-beaked dolphins (*Lagenorhynchus albirostris* Gray 1846) recorded in Icelandic waters. *Journal of the Acoustical Society of America, 111*(2), 1122-1125.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. (1995). Marine Mammals and Noise. Academic Press, San Diego. pp. 91.

Simmonds, M., Dolman, S. J., Weilgart, L., Owen, D., Parsons, E. C. M., Potter, J. & Swift, R. J. (2003). Oceans of Noise *A WDCS Science Report*. Whale and Dolphin Conservation Society (WDCS).

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene, C. R., Jr., Tyack, P. L. (2007). Marine mammal noise exposure criteria: initial scientific recommendations. [Journal Article]. *Aquatic Mammals, 33*(4), 411-521.

Thompson, T. J., Winn, H. E. & Perkins, P. J. (1979). Mysticete sounds H. E. Winn and B. L. Olla (Eds.), *Behavior of Marine Animals* (Vol. 3: Cetaceans, pp. 403-431). New York: Plenum Press.

Urick, R. J. (1983). Principles of Underwater Sound. Los Altos, CA: Peninsula Publishing.

Watkins, W. A. (1980). Acoustics and the behavior of Sperm Whales R. G. Busnel and J. F. Fish (Eds.), *Animal Sonar Systems* (pp. 283-290). New York: Plenum Press.

Wenz, G.M. (1962). Acoustic ambient noise in the ocean: Spectra and sources. *Journal of the Acoustical Society of America* 34:1936-1956.

Young, R. W. (1973). Sound pressure in water from a source in air and vice versa. *Journal of the Acoustical Society of America, 53*(6), 1708-1716.